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Elri Liebenberg
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History of Cartography

International Symposium of the ICA, 2012

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Preface

This volume comprises most of the research papers presented at the 4th International Symposium of the ICA Commission on the History of Cartography which took place at the Eötvös Loránd University in Budapest, Hungary, on June 28–29, 2012. As such this is the second volume in a series which has been made possible through the partnership between the International Cartographic Association (ICA) and the international publishing house of Springer-Verlag.

The ICA was founded in 1959 and, as the world authoritative body on cartography, it has, as its mission, the promotion of the discipline and profession of cartography on as wide a scale as possible. The ICA is basically a technical organisation of professional cartographers who are concerned with current aspects regarding researching, compiling and producing maps. As historical maps and historical cartographic material are in integral part of any modern cartographic database, the ICA also maintains a keen interest in the research on the evolution of modern cartography. In its effort to promote this interest, the ICA Commission on the History of Cartography considers it its responsibility to encourage the active involvement of all interested researchers and institutions in this field.

The history of cartography covers a vast field of knowledge and includes all maps and map-like graphics made by humankind since prehistoric times. Map compilation and map-use today are, however, seldom dependent on maps which were produced before early modern times. With this point in mind, the ICA Commission decided to concentrate on the history of cartography since the Enlightenment and, more specifically, on cartographic developments during the nineteenth and twentieth centuries.

The 4th International Symposium of the ICA Commission on the History of Cartography had, as its general theme, “Exploration—Discovery—Cartography”. The nineteenth century was a period characterised by a quest for empirical knowledge with regard to the geography of the earth, marked by voyages of exploration by sea and land. The exploration undertaken by governments, institutions and individuals inevitably led to discovery as well as to mapping which filled up the empty white spaces so common on maps of the eighteenth century. While contributions towards this general theme were encouraged, the Symposium was also open to relevant research on cartographic endeavours other than exploratory mapping. At the symposium in Budapest 24 papers were presented, and this volume contains the revised and edited version of twenty of these. Some papers could unfortunately not be included, and because of limited space, none of the eight poster presentations could be published.

We would like to acknowledge our gratitude to the Eötvös Loránd University in Budapest, and especially to the Head of the Department of Cartography and Geoinformatics and Secretary-General of the ICA, Prof. László Zentai, for the logistic support he rendered during the Symposium. We are also indebted to the Director of the University Library, Dr. László Szögi, and to Dr. Máté János Bíbor and his colleagues at the Library's Department of Special Collections, as well as to Mrs. Marianna Nyitrai and her staff, for the map exhibition and reception in the library building. The symposium participants are grateful to Ph.D. students Domonkos Hillier, Ádám Bérces and János Jeney for their technical assistance throughout the meeting. Finally, we gratefully acknowledge the kind assistance of Ms. Agata Oelschläger of Springer-Verlag towards the production of this book.

Pretoria, RSA — Elri Liebenberg
Portsmouth, UK — Peter Collier
Budapest, Hungary — Zsolt Györö Török

Contents

Part I
Europe

Redefining Imperial Borders: Marking the Eastern Border of the Habsburg Monarchy in the Second Half of the Eighteenth Century

Madalina Valeria Veres

Abstract In the eighteenth century, Eastern Europe became the stage for concurrent imperial expansion projects. The Habsburg-Russo-Ottoman military confrontations plagued the Danubian principalities of Moldavia and Wallachia, located immediately next to the eastern borders of the Habsburg Monarchy. Despite their alliance with Catherine the Great, the Habsburg rulers Maria Theresa (1740–1780) and Joseph II (1765–1790) witnessed fearfully from their Eastern province of Transylvania the Russian encroachment into the Ottoman lands. At such a time, Habsburg interests in the area had to be incessantly negotiated with their powerful rivals, and cartography became a strong weapon in defending Habsburg territory and even furthering expansionist projects. Historians have shown how the depiction of political borders on maps constituted an early-modern development, and how the concept of "border" acquired a linear visual expression with the help of cartography. In this paper I examine this transformation of the eastern border of the Habsburg Monarchy, namely the border of Transylvania with Moldavia. Using archival documents found in Vienna and Paris, I focus on Habsburg explorations and mapping enterprises from the 1750s to the mid-1770s on their eastern border. Whereas the 1750s maps of Stephan Lutsch von Luchsenstein encompassed the first detailed visual representation of the border regions, by the 1770s the Habsburgs had put into place an impressive system of imperial landmarks and had even infringed into Moldavian territory. I argue that cartographic representations of these borders gave weight to Habsburg pretensions in the region.

1 Introduction

On 23 December 1769 an unwanted visitor disturbed the guard watching over the eastern border of the Habsburg Monarchy. The engineer Phillip von Möller, employed by the Russian army, had come all the way to the Carpathian Mountains separating the Habsburg province of Transylvania from the Principality of

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Moldavia to investigate the accurate position of the border (HHStA StK, Noten von dem HKR, Karton 82, Fasz. 1: 16). Möller's seemingly innocent questions provoked a panicked reaction from the Habsburg side, and by 7 January 1770, Emperor Joseph II had already received a detailed report about this incident. The reason for such a commotion was the bold step the Habsburg Monarchy had taken in 1769, when Emperor Joseph II and Empress Maria Theresa had decided to push forward the Transylvanian border infringing on the lands of the Danubian Principalities, Moldavia and Wallachia. Taking advantage of the war between the Russians and the Ottomans, the Habsburgs transformed their decades-old claims into reality and acquired better strategic positions in the Carpathian Mountains.

At a time when European empires were striving to mark their borders more clearly and eliminate enclaves, the Habsburg Monarchy was an active participant in this process. However, the ideal frontiers the Habsburgs tried to attain did not go unchallenged and the competing Russian, Ottoman and Habsburg claims for domination met in the lands of the Danubian Principalities (Aksan 2007; Hochedlinger 2003; Roider 1982). In my paper I examine how despite these strong challenges, the Habsburg Monarchy managed not only to demark the border of Transylvania with Moldavia to their advantage, but also to claim successfully what was in fact the northern section of the Principality of Moldavia.

I argue that in addition to the international context which favoured the Habsburg claims, cartographic representations and geographic descriptions of the border regions gave weight to and helped finalize Habsburg territorial pretensions by 1775. Indeed, starting in the early 1750s, the Habsburg engineers accumulated a corpus of maps and other documentary evidence to support a redrawing of the Transylvanian border towards Moldavia. The correspondence between the State Chancellery and the Aulic War Council in Vienna addressed the mapping projects coordinated by the War Council at the borders of Transylvania and the efforts of the military to mark the eastern border of the Habsburg Monarchy. The reports of the French ambassadors in Vienna analyzed in depth the Habsburg actions in their eastern lands and their expansion attempts; moreover, French diplomats of the time often obtained copies or information about secret imperial Habsburg orders and reports, thus offering further insight into the Habsburg policy.

Some scholars have mentioned in their work the existence of border maps for Transylvania and discussed how the 1775 Habsburg annexation of the northern part of Moldavia, Bukovina, was preceded by cartographic operations (Hochedlinger 2003: 356–358; Ceauşu 1998: 52–59; Paldus 1919). Moreover, in the context of the formation of the Habsburg military border in Transylvania starting with the second half of the eighteenth century, scholars have addressed the incessant border disputes the inhabitants of Transylvania and the Habsburg authorities had to settle with the Danubian Principalities (Göllner 1973; Micu 1943). However, none of these historians focused on the relationship between the mapmaking operations and the marking of the eastern border of Transylvania, which kept Habsburg military engineers engaged from the 1750s to the 1770s. Using the history of cartography's methodology can bridge this gap.

John Brian Harley revolutionized the history of cartography by encouraging scholars to read maps as they would other historical documents, to go beyond their purely illustrative role (Harley 1990: 3). Furthermore, Harley built on Foucault's discussion of the relationship between power and knowledge, and stressed the importance of maps as tools furthering the power of a state (Harley 1988: 58–59; Harley 2002: 57–58). However, Harley's approach has been nuanced by recent historians of cartography, who did not simply admit that comprehensive maps served state interests without being challenged (Edney 1996: 189). Indeed, as my paper shows, imperial policies often conflicted with their neighbours' claims and their own subjects' ambitions.

Paul Mapp's recent book reveals the importance of analyzing cartography in a trans-imperial context. This historian shows the impact geographical perceptions of the western part of North America had on eighteenth century imperial diplomacy. In their "race towards the West", the British, French, and Spanish empires relied heavily both on indigenous peoples' and their European competitors' geographic knowledge (Mapp 2011). Following in Mapp's footsteps, this paper examines how cartography influenced the redrawing of the eastern border of the Habsburg Monarchy, while also bringing to light the intense negotiations the Habsburgs had to pursue with not only the Ottoman and Russian Empires, but also with the local inhabitants of the principality of Moldavia.

Historians of cartography examining the maps commissioned from Vienna in the second half of the eighteenth century have usually focused on one province of the Monarchy and they have rarely made connections with other parts of the empire. In the case of the imperial border delimitation, scholars have thoroughly examined this process for the Austrian Netherlands. As Nelly Girard d'Albissin demonstrated, the border between France and the Austrian Netherlands was marked clearly as a consequence of the treaties signed in 1769 and 1779 between the Bourbons and the Habsburgs. This legal historian shows how increased map-making accuracy was used to trace the borders while, at the same time, the existence of advanced map-making technology encouraged the border surveyors to draw clearer frontier lines (d'Albissin 1970; Dubois 2001; Lentacker 1974; Watelet 1992). Indeed, the engineers' ability to take exact measurements and make maps, thus tracing a precise line of demarcation, led to further negotiations between Paris and Vienna and the elimination of additional enclaves. However, whereas until now scholars have treated the demarcation of the border between France and the Austrian Netherlands in isolation, I will show that a similar process occupied the Habsburgs in the 1770s in their efforts to mark a frontier line towards the Danubian Principalities. These two cases demonstrate that Maria Theresa and Joseph II had a clear programme for defining the contours of their empire.

2 The First Detailed Maps of the Border Between Transylvania and Moldavia

In the sixteenth and seventeenth centuries, Ottoman control over Transylvania posed a significant threat to the security of the Habsburg Monarchy, and this Principality maintained a high geopolitical value in the Habsburg-Ottoman confrontation (Ingrao 2000: 65). However, towards the end of the seventeenth century, the Habsburgs gained the upper hand in the area against the Ottomans. By signing the 1699 Treaty of Karlowitz, the Ottoman Empire confirmed the Habsburg military's conquest of Hungary and Transylvania, and this treaty brought with it the desire to regulate the new imperial borders (Magyari 2009: 343–355). As Virginia Aksan contends, the Ottomans had become potential partners in regulating the exact position of borders, as in the eighteenth century, the rulers in Constantinople strove for fixed boundaries and "permanent" peace (Aksan 2006: 76). Indeed, by 1741 the Habsburgs had sealed an agreement with the Ottomans which fixed the border between the Principality of Moldavia and the Principality of Transylvania high in the Carpathian Mountains, on the watershed (Porcius 1928: 14). However, such a vague principle did not easily translate into a clear frontier line, and it was impossible to enforce a strict separation between the inhabitants of Moldavia and Transylvania, who often trespassed into each other's lands.

Due to the nonexistence of one accepted border between Transylvania and Moldavia, the early 1750s witnessed the creation of competing border maps representing the interests of the Moldavians and Transylvanians. In 1750, the Court in Constantinople, acting as a representative for the Moldavian prince's interests, sent to Vienna a map of the border between Moldavia and Transylvania, supporting Moldavian claims (KA KPS, B IX c 744). Vienna's reaction was immediate: an Imperial Order was sent from Vienna to the General Commander of Transylvania, Count Maximilian Ulysses von Browne, to obtain an accurate survey and border map, together with other documentary proofs that would support the Transylvanian pretentions in the border regions shared with Moldavia. Browne put in charge of this mission Captain Stephen Lutsch von Luchsenstein, a Saxon from Transylvania. Whereas von Luchsenstein finished the required map by 1751, he took six more years to finalize a detailed memoir in which he attacked the map sent from Constantinople, while also discussing all the controversial points on the border and trying to demonstrate the Habsburg claims in the area (KA KPS, B IX c 744).

Luchsenstein raised serious doubts about the accuracy of the map supporting Moldavian claims, based on its inaccurate representation and incongruities between the map and on-ground toponyms. Throughout his memoir Luchsenstein gives numerous examples such as his claim on page 2, which states that the villages Vuolidania, Pitrechun, Karavul Cskivarda and others, and the mountains Tzapaf, Arhir, Kosder cannot be found anywhere in reality except on the Moldavian map (KA KPS, B IX c 744). In addition to erroneous names for villages and geographic features, the Habsburg officer also considered this map closer in style to a painting than to an actual accurate land survey, and accused the cartographer of having used only oral reports to draw it. Luchsenstein's assessment criteria are congruent with eighteenth-century ideas on what made a map accurate and "scientific". In the second half of the eighteenth century, European scientists came to consider topographical surveys based on geometrical frameworks of triangulation and the use of special instruments to measure distances as the necessary prerequisite of "good" maps (Edney 2009: 41–42). Knowing the represented land first-hand had become a necessary condition for the reliability of a cartographic source and, as map-making became a science, using symbols to codify the landscape had become the norm (Godlewska 1999: 44–49).

Despite a close scrutiny of the 1782–1783 inventories of the War Archive's Map Collection (KA HKR 1782 34 105; KA HKR 1783 34 60), the only trace of the 1751 Moldavian map I have recovered in the Viennese archives was located in the title of the counter-map drawn by Luchsenstein in 1751. However, whereas I could not find this Moldavian map, I have retrieved a 1755 map which helps to illustrate the type of cartographic representations the Habsburgs challenged in the 1750s. This map, labelled in the 1782 map collection inventory as a "Turkish drawing", contains a bilingual explanation, in German and Ottoman Turkish, which suggests that its audience was the Habsburg and Ottoman Courts. The map's explanation indicates that it is a representation of part of the contested border between Transylvania and Moldavia, and it claims that the goal of the mapmakers was to put a stop to the Transylvanians' abuses in the area by clarifying the real position of the border (KA KPS, B IX c 748).

Luchsenstein's critique of the 1751 Moldavian map's graphic representation could also apply to this 1755 map. As seen in the fragment below, the representation supporting the Moldavian claims clearly did not meet the criteria of the emerging scientific conventions mentioned above. In depicting the town Kiesti, the mapmaker disregarded the natural proportions of buildings in relationship to landscape features and vegetation, such as mountains and trees. Moreover, the image does not include the road network and the placement of buildings in relationship to each other; the viewer only sees a cluster of houses and churches (KA KPS, B IX c 748) (Fig. 1).

In his 1757 memoir Luchsenstein does not only attack the scientific quality of the Moldavian map, but also refutes the principle according to which the border should traverse the peaks of the mountains and take into account the watershed as a geographical entity dividing the two territories. The Habsburg military's main argument against this principle is the Moldavians' inconsistency regarding their border delimitation, as the border separating Moldavia from Poland and Wallachia does not enforce the watershed rule. A section of the Moldavian and Polish border follows the flow of

Fig. 1 Fragment from the 1755 map showing the Moldavian pretensions at the border with Transylvania (Courtesy of the Kriegsarchiv, Vienna) (KA KPS, B IX c 748)

stream, while part of the border dividing Moldavia and Wallachia is located on the Jabola Pudna River. Moreover, Luchsenstein attacks the validity of the five written pieces forwarded to the Court in Vienna by the Moldavian Prince, and which included the evidence for the Moldavian pretensions in the border area. I have not located these five documents in the archives in Vienna, but they are discussed in Luchsenstein's memoir (KA KPS, B IX c 744). Using historical documents, such as the ones gathered during the 1642 border investigation coordinated by the Transylvanian prince George Rákóczi II and the Moldavian prince Vasile Lupu, Luchsenstein presents the Habsburg pretensions as a just enforcement of the ancient border between Transylvania and Moldavia. Moreover, the cartographer argues that Hungarian toponyms as exhibited by a long list of mountains and rivers located in the contentious border regions denote those areas as Transylvanian (KA KPS, B IX c 744).

In contrast to the map discussed above, Luchsenstein presented an alternate representation of the border by focusing on the landscape and following the mountainous chain as a guideline. This cartographer included in his map three border lines: the so-called ancient border between Transylvania and Moldavia, the border enclosing the Transylvanian possessions at the time, and the "unlawful Moldavian pretensions" (KA KPS, B IX c 744) (Fig. 2).

As can be seen in Fig. 2, the mapmaker marked the various moments of what he calls the Moldavian usurpations, from 1727, 1733, 1734, 1735 and 1746 (KA KPS, B IX c 744). Numbers from 1 to 100 mark the points of interest located on the three competing border lines. These numbers helped Luchsenstein to organize his exposé, as the Habsburg officer included in the memoir more geographic information about all these points of interest.

For example, Fig. 3 includes the Borda Mountain, denoted by number 39. It is plausible to state that the documents accompanying the map supporting the Moldavian pretensions mentioned a stone located on the Borda Mountain, which had been incised with a Moldavian coat of arms, as Luchsenstein devotes a long paragraph to counteracting this declaration. Luchsenstein seems to have seen the above-mentioned stone first hand as he describes the signs as the mere doodles of idle herdsmen, and in no way reminiscent of an official coat of arms (KA KPS, B IX c 744).

As proven by Luchsenstein's memoir, the Transylvanian side had a strong documentary-base supporting their border claims. However, probably due to the turmoil created by the Seven Years' War (1756–1763), the Habsburg monarchs had to wait until the 1768–1774 Russo-Ottoman war to transform their intentions in the area into actions.

3 The 1768–1774 Russo-Ottoman War and the Habsburg Border Markers

The official neutrality of the Habsburgs in this Russo-Ottoman conflict did not translate into actual non-involvement. Maria Theresa and Joseph II knew that at any point the conflict might overflow to move inside their borders and they had to

Fig. 2 The 1751 Luchsenstein Map of the border between Moldavia and Transylvania (Courtesy of the Kriegsarchiv, Vienna (KA KPS, B IX c 744)

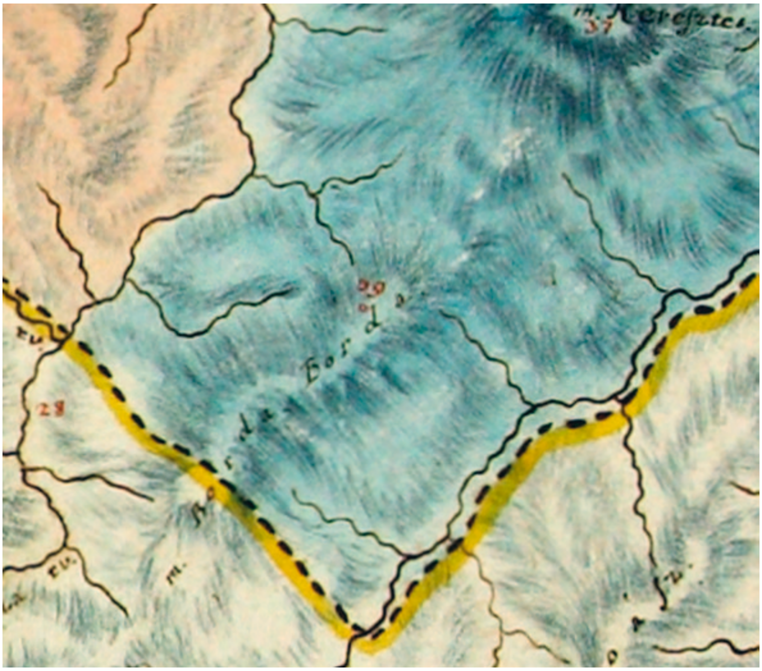

Fig. 3 Detail from the 1751 Luchsenstein Map of the border between Moldavia and Transylvania presented in Fig. 2 (Courtesy of the Kriegsarchiv, Vienna)

be prepared (Aksan 2007; Hochedlinger 2003; Roider 1982). The Habsburgs also used this justification for military preparedness to order their border regiments to set Transylvania's frontier markers into Moldavian and Wallachian territory and to actually map part of the Danubian Principalities. The Viennese policy makers justified all these border adjustments and mapmaking operations in front of the other European political players as mere precautionary gestures (KA HKR 1773 57 60). However, the Habsburg unilateral border adjustments did not unfold unobstructed. The local inhabitants of Moldavia provided the occupying Russian troops with arguments in favour of opposing the confirmation of the new border. In the end, the Habsburg preparatory steps, such as the 1750s Luchsenstein mapping operations, helped the court in Vienna to defend their claim.

Less than a year after the beginning of the Russo-Ottoman conflict, on 1 March 1769, the president of the Aulic War Council, Count Frantz Moritz von Lacy, expressed his concern that a lack of clear markers on Transylvania's borders made it vulnerable in the face of the opposing Ottoman and Russian armies, especially in the case of a Russian invasion of Moldavia and Wallachia. Neither Transylvania's Military Commander, Count Karl O'Donnell, nor his superior, Lacy, predicted any difficulties in positioning these border markers, but both of them foresaw challenges at the end of the war from either the Ottoman or the Russian side. Therefore, Lacy presented a number of scenarios contingent on the unfolding of the war. In the case of a Russian invasion of Moldavia, the Habsburg troops could position the border markers without any restraint and even occupy earlier controversial frontier areas. Lacy assumed the Russians would have difficulties in challenging this new status quo. However, if the principality remained in the Ottoman sphere of influence by the end of the war, the Porte would surely contest the new position of the border markers, and the Habsburgs should voice their willingness to name a joint commission to decide on the legitimate position of the border (HHStA StK, Noten von dem HKR, Karton 81, Fasz. 1: 33–34). Lacy's recommendation was rooted in the Habsburgs' earlier experiences in trying to negotiate with the Ottomans. The unfruitful diplomatic confrontations from the early 1750s had convinced the Habsburgs that in the case of an official investigation to mark the position of the border between Transylvania and Moldavia, their cartographic and detailed documentary evidence, supported by their military power, would have a good chance to counteract any pretensions from the Ottoman side.

Lacy's plan received imperial approval and by the end of June 1769, Joseph II decided that the trigger to start positioning the border markers should be the Russian invasion of Moldavia. The emperor warned his military staff to claim only lands for which the Viennese Court could provide convincing evidence of ownership, in order to thwart any counter-claims at the end of the war. Moreover, if the fighting sides expressed any misgivings about the Habsburg actions, Joseph II recommended that his men present the act of positioning border markers as a temporary defensive measure, simply aimed to protect the Principality of Transylvania from the war devastation (HHStA StK, Noten von dem HKR, Karton 81, Fasz. 1: 22–27).

The Viennese decision makers knew that the best maps of the border areas of Transylvania were Luchsenstein's. However, these maps lacked the representation of any border markers. Therefore, on 22 May 1769, Luchsenstein was ordered to include signs for the frontier pillars on his maps (KA KPS, B IX c 757). I have located a post-1775 copy of Luchsenstein's map which includes his earlier representation of the border together with the border markers added at the end of the 1760s. An examination of the map's legend reveals the addition of a new symbol for border markers, and a close inspection of the frontier line's representation discloses marks added to the original drawing. A small fragment reproduced below exemplifies these map-modifications. This section shows the same area as Fig. 3 above, the Borda Mountain and its surroundings (Fig. 4).

The bottom line indicates the limit of Transylvania in 1751 and the shaded area indicates a piece of land "usurped" by the Moldavians before 1727. However, the sign denoting border marker 15 appears on the map close to the upper dotted line marking, by what the Habsburgs called the "ancient" border, thus "re-claiming" the "usurped" territory. The map's legend reveals that the border markers were placed in 1769 and their position was confirmed at the end of the war, in 1775 (KA KPS, B IX c 757).

By the Fall of 1769, the Habsburgs had moved more regiments into Transylvania and had reinforced the military cordon to oppose the Ottoman Empire. As the French ambassador in Vienna, the Marquis de Durfort, wrote to the French foreign minister in Paris, Étienne François Duke de Choiseul, Chancellor Kaunitz wanted to reassure the foreign diplomats in Vienna that this was not an aggressive

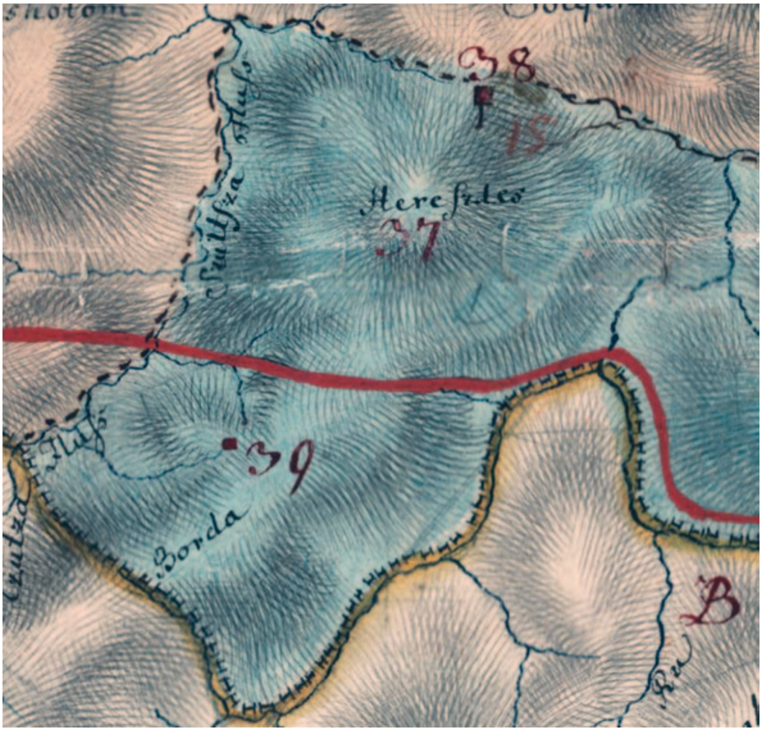

Fig. 4 Detail from the copy of Luchsenstein's Map done by Cadets Promig and Fischer after 1775 (Courtesy of the Kriegsarchiv, Vienna) (KA KPS B IX c 757)

gesture, but simply a precautionary measure (MAE CP Autriche, 312: 78 verso-79; 119 verso-120 verso; 209–209 verso). However, under the veil of protecting the Transylvanian province from an Ottoman or Russian invasion, the Habsburg troops were redrawing the frontier line, and the only complaints they had to face until October 1769 were from the Moldavian inhabitants living in the so-called reclaimed areas (HHStA StK, Noten von dem HKR, Karton 81, Fasz. 2: 84).

Even after the Russian and the Ottoman Empires raised real challenges to the Habsburg plans in the border areas, the agency and influence of the local inhabitants of Moldavia should not be underestimated. As Peter Sahlins has shown for the marking of the French-Spanish border in the Pyrenees, local communities played an active part in the process of their identity formation and did not easily abandon their local interests and sense of place in the face of nation-building projects (Sahlins 1989). The Moldavian actions against the Habsburg pretentions had slowed down Vienna's ambitions for decades before the Russo-Ottoman conflict and in the early 1770s undermined the positioning of the border markers either directly or with the help of the Russian military commander who had invaded the province.

It did not take long for the Moldavians' dissatisfaction regarding the Habsburg unilateral border demarcation to erupt into violent acts. In the winter of 1769, Szavuka Ioun, an inhabitant from a Moldavian village close to the border, demolished a newly-installed Habsburg border marker. The Aulic War Council's orders to the commander in Transylvania made it clear that the Habsburg authorities would not allow any other similar actions and that the Transylvanian guards would not hesitate to use force to defend the border markers (HHStA StK, Noten von dem HKR, Karton 82, Fasz. 1: 33 verso-34 verso). As the Russians had controlled Moldavia since the fall of 1769, the Habsburgs refused to negotiate directly with the Moldavians and communicated only with the occupying forces. With the approval of Emperor Joseph II, Chancellor Kaunitz commanded General O'Donnell to ask the Russian General in Moldavia to bring the demolished border marker to its initial position (HHStA StK, Vorträge, Karton 105, Fasz. 1: 13).

Despite officially being allies with the Russian Empire, the Habsburgs did not trust Empress Catherine II and did not want to witness the transformation of the temporary Russian occupation of the Danubian principalities into a permanent status quo. The Habsburgs became alarmed when in 1770 the Russians demanded the right to control Moldavia and Wallachia for 25 years (Hochedlinger 2003: 352). Causing further alarm, shortly after the Russian invasion, Catherine II encouraged the inhabitants of Moldavia and Wallachia to join her armed forces in exchange for a good wage (MAE CP Autriche, 312: 227). This promise had an impact on not only the Danubian Principalities. In less than six months, more than three thousand people from Transylvania had crossed the border and joined the Russian troops. This phenomenon only confirmed to the Habsburgs the danger of having Russia as a neighbour, especially in the proximity of the Principality of Transylvania and the Hungarian Kingdom, who, according to contemporary estimations, numbered more than 600,000 Greek-Orthodox inhabitants who recognized Russia's spiritual leadership (MAE CP Autriche, 313: 98 verso-99 verso).

The Habsburg distrust of their allies impacted on the border-marking operations. General O'Donnell foresaw that once the Russian generals figured out that the Habsburgs were marking the border to further Viennese territorial ambitions, they would challenge this action. The official answer Chancellor Kaunitz instructed the Habsburg officers to offer to any Russian queries, was to stress the defensive justification for the border marking. Furthermore, General O'Donnell was instructed to inform his Russian counterpart that the Courts of Saint Petersburg and Vienna should continue the discussion regarding the frontier line at a higher level (HHStA StK, Vorträge, Karton 105, Fasz. 1: 13). Refusing to negotiate directly with the Moldavians, who could have expressed their claims to the border lands with solid evidence, made it harder for the Russians to challenge the Habsburgs' actions but did not prevent their interference.

As soon as the spring of 1770 came, General O'Donnell forwarded to Vienna worrying news about the Russian officers' plans regarding the frontier markers (HHStA StK, Noten von dem HKR, Karton 82, Fasz. 1: 411). Corporal Wittibschlager, a Habsburg spy posing as a cattle merchant, travelled into Moldavia at the end of April 1770 and met the Russian Corporal in charge of the area around the market-town Campolongo. Wittibschlager found out that the Russian army was repairing the road leading from Campolongo to the border markers in the area of Kosnitza. As soon as the snow in the mountains started melting, the plan was for 800 Russian soldiers to travel into the Carpathians to push back the newly installed frontier markers (HHStA StK, Noten von dem HKR, Karton 82, Fasz. 1: 418–419). A message coming from Peter Szilagyi, another Habsburg spy masquerading as a Russian collaborator, confirmed Wittibschlager's intelligence: the Russians were planning to displace the border markers and challenge Vienna's action (HHStA StK, Noten von dem HKR, Karton 82, Fasz. 1: 417). This Russian initiative against the border markers was justified as a response to the Moldavians' complaints. The Habsburg spies commented on the enthusiastic support the inhabitants from the Moldavian border town of Dorna had promised the Russian troops in their efforts to get rid of the border markers (HHStA StK, Noten von dem HKR, Karton 82, Fasz. 1: 418–419).

Not all of the Moldavian actions against the Habsburg-imposed status quo were overtly violent. On 31 March 1770, Lieutenant Colonel Caratto notified his superior, O'Donnell, that according to an old custom, the Moldavian inhabitants had started to graze their sheep and cattle on lands which were now marked as Transylvanian territory. However, while the Habsburg authorities had no use yet for those pastures and could ignore a small number of grazing animals, they could not passively witness the Moldavians' trespass into Transylvania. If the Habsburgs ignored these actions, it would be like conceding that those lands were not really part of the Habsburg Monarchy (HHStA StK, Noten von dem HKR, Karton 82, Fasz. 1: 254–254 verso). Therefore, on 30 April 1770, the Aulic War Council ordered the General Commander in Transylvania to punish any trespassers even if that implied confiscating their cattle. Moreover, in the case of any Moldavian complaints to the Russian occupying forces regarding the Habsburg actions, the official answer the Habsburg militaries had to offer was that they were simply protecting Transylvanian territory. In this same order, President Lacy stressed the importance of accelerating the process of gathering all necessary documentary evidence to prove the Habsburg rights on the claimed border areas in order to accelerate future negotiations. Furthermore, the Viennese authorities decided it was time to notify the Habsburg representative in Constantinople, Baron Franz Maria von Thugut, about the border marking operations, so that this ambassador could negotiate with the Porte's representatives (HHStA StK, Noten von dem HKR, Karton 82, Fasz. 1: 277–280 verso).

The Moldavian challenges to Habsburg authorities also involved local elites. On 11 November 1770, Colonel Enzenberg informed O'Donnell that a group of four Wallachian families, whose territory had been recently enclosed as part of Transylvanian land, had been menaced by the local Moldavian nobleman. This potentate had prohibited the four families to pay any taxes to the Habsburg authorities. When transmitting Enzenberg's message to Vienna, O'Donnell expressed his reluctance to challenge the nobleman and risk exposing Transylvanian troops to a plague epidemic that had started making ravages in the Danubian Principalities (HHStA StK, Noten von dem HKR, Karton 83, Fasz. 1: 169). The Aulic War Council's order made it clear that as soon as the danger of a plague contagion disappeared, the military authorities had to include the four families into the Habsburg lists of tax payers (HHStA StK, Noten von dem HKR, Karton 83, Fasz. 1: 173–173 verso).

The incidents discussed above show that the local Transylvanian authorities had to confront various types of challenges in solidifying the new border demarcation. The local inhabitants of Moldavia ignored or displaced the border markers, and tried to take advantage of the Russian military force's presence in their territory to counter the Habsburg demands. Additionally, the Viennese decision makers had to take into account the possibility of Ottoman and Russian attacks on the new border demarcation at the end of the war. Emperor Joseph II's visit to the province of Transylvania in 1773 proved instrumental in paving the way for the Habsburgs to defend their border claims after the end of the Russo-Ottoman war. The Habsburg monarch's visit also demonstrates that Viennese political elites did not coordinate the cartographic operations only from a distance. Therefore, in the following section I analyze Emperor Joseph II's direct involvement in the survey and marking of the Transylvanian border with the Danubian Principalities. Moreover, I argue that the imperial visit to Transylvania triggered Joseph II's desire to incorporate the northern part of Moldavia into the Habsburg Monarchy.

4 Joseph II'S 1773 Journey to Transylvania and the Annexation of Bukovina

Scholars have examined the numerous journeys Joseph II made into his various provinces and outside the Monarchy (Bozac and Pavel 2006; Donnert and Reinalter 1996; Hubert 1900; Wagner 1965; Beales 1987, 2009). My research adds a new angle to this examination as I contend that Joseph II's desire to personally know his empire's lands first-hand also fostered the emperor's interest in cartography. Detailed maps could substitute for first-hand knowledge of a region and inform imperial policies.

During his 1773 journey to Transylvania, Joseph II invested time and resources into expanding the cartographic projects in these areas and their bordering territories (Veres 2012: 152–155). Foreign ambassadors in Vienna commented on the emperor's itinerary during his approximately two-month visit to Transylvania and saw it as a reflection of Joseph II's political ambitions. Indeed, some of the main objectives the emperor inspected during his trip included salt mines, one of the main sources of revenues for the Monarchy, and various defence points on the border. Whereas Joseph II's interest in firsthand reconnaissance was already known, on 29 May 1773, Louis René Édouard, Cardinal de Rohan, the French ambassador in Vienna, transmitted with evident worry to Paris the emperor's decision to pass incognito for one day into Moldavia to meet the Russian army's commander, Field Marshal Romanzow (MAE CP Autriche, 321: 367–369). This news was worrisome to the French diplomat as it could have signaled Joseph II's decision to join the conflict against the Ottomans in order to expand the Habsburg Monarchy's territories.

However, Joseph II did not plan any war declaration against the Ottomans. It is more plausible that his meeting with the Russian general was connected to the Habsburg enterprise of marking the border between Transylvania and Moldavia, as well as Joseph II's desire to obtain accurate cartographic representations of the border regions of both Moldavia and Wallachia. Indeed, less than two weeks after this meeting, on 10 July 1773, Joseph II ordered the president of the Aulic War Council, Lacy, to extend the map of Transylvania into the border area of Moldavia and Wallachia. The emperor mentioned that his decision was based on prior consultation of both the military map done by the General Staff of the Habsburg Army and a copy of the map of Moldavia and Wallachia done by the occupying Russian troops. The emperor had noticed that all these maps had a faulty representation of the main passes, roads and footpaths, and therefore were useless in developing offensive and defensive plans. Joseph II's order to extend the military map of the General Staff into the lowlands of Moldavia and Wallachia prioritized speed over accuracy. The map-makers had to include the exact description of the road conditions, the names of the settlements in the local language, and a representation of mountains, lakes, rivers together with observations on whether they can be passed on horse, by foot, or with artillery. The imperial order encouraged collaboration with the Russian officers and respect for the Moldavian inhabitants on whose territories the engineers would trespass. However, the emperor also recommended avoiding unnecessary information disclosure, especially regarding the topic of the border markers (KA HKR 1773 57 60).

By 19 October 1773, Major Mihály Lajos Jeney (Jankó 2006), who had directed the military surveying of the province of Transylvania since 1772, notified his superiors in Vienna that the map of the border area of Moldavia and Wallachia had been completed and that it covered over 200 Austrian square miles or approximately 1,500 kilometres (Cardarelli 2003: 99). During the winter of 1773–1774, Jeney worked with a team of ten military engineers to transform the draft-maps into clean copies (KA HKR 1773 57 101). The final sections of this border map extended the military map of Transylvania known in the literature as the Josephinische Aufnahme (Paldus 1919). The figures below show the layout-schemes for this map of Transylvania and the way in which the border maps' sections were numbered to correspond with the Josephinische Aufnahme's older sections (Figs. 5, 6).

The border map of Moldavia included 48 sections and the one for Wallachia encompassed 55 sections. Whereas the Josephinische Aufnahme had at most included a schematic landscape representation for non-Transylvanian territory, the new border maps represented part of the Moldavian and Wallachian territory as meticulously as on the Josephinische Aufnahme. The stretch of land represented on the new border maps extends all the way into the lowlands and the first significant Moldavian settlements close to the frontier. Settlements located in the lowlands of the Danubian Principalities were represented on the new border maps as detailed as on the map of Transylvania. For a comparison we can examine two villages: Szent Simon (Sânsimion) from Transylvania and Dormanyesd from Moldavia. Despite the difference in size, the mapmakers have represented the villages in a similar style. In both cases, the orientation of the houses, their gardens, the church, mills and other buildings, together with the surrounding landscape, are all represented in detail. The detailed attention given to the settlements' representation proves that Joseph II conceived the Border Maps of Moldavia and Wallachia as additions to the Josephinische Aufnahme (Figs. 7, 8).

Clearly, the Habsburg project of mapping part of the Moldavian and Wallachian territory was successful in obtaining detailed representations of the border areas.

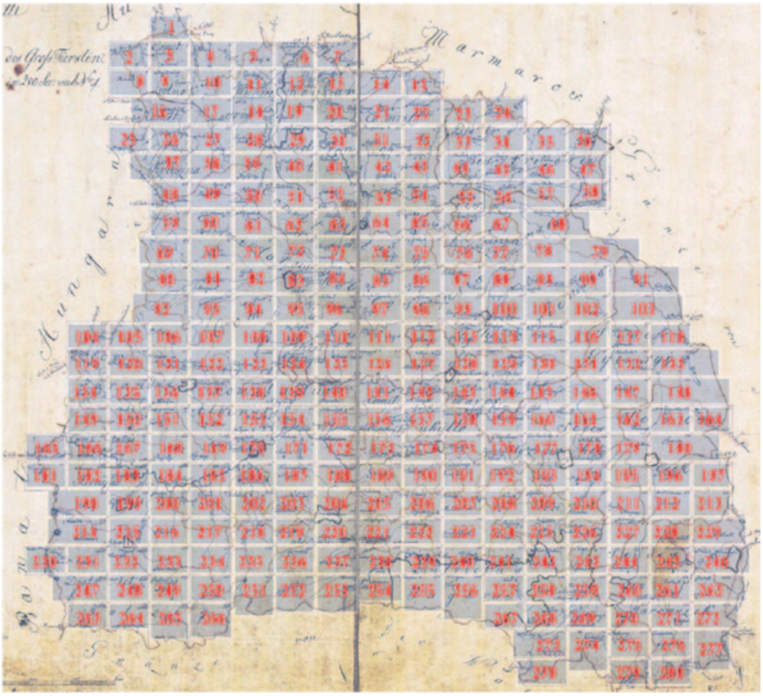

Fig. 5 Layout of the 1769–1773 Josephinische Aufnahme (Az elsö Katonai)

Fig. 6 Fragment of the layout of the 1773 border map of Moldavia (Courtesy of the Kriegsarchiv, Vienna) (KA KPS, B III c 038, Esquelette)

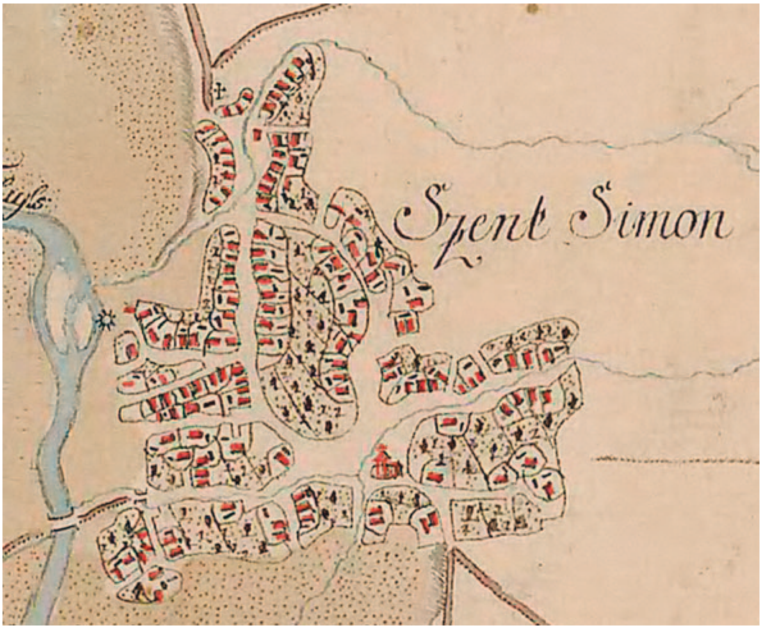

Fig. 7 Village Szent Simon on the Josephinische Aufnahme (1769–1773) (*Az első Katonai*, Section 212)

Fig. 8 Village Dormanyesd on the 1773 border map of Moldavia (Courtesy of the Kriegsarchiv, Vienna) (KA KPS, B III c 038, Section 37 for Moldavia)

Moreover, part of what started as an extension of an earlier map became an important step in expanding the actual borders of the Monarchy. During his journey to Transylvania and the newly acquired territories in Poland, Joseph II discovered that the best way to connect Transylvania and Galicia ran through the northern section of Moldavia (Roider 1982: 140). In this sense, just mapping the northern part of Moldavia was no longer enough.

In the summer of 1773, the emperor sent Colonel Carl Baron von Enzenberg, the commander of the second border Wallachian Infantry Regiment from Transylvania, to inspect the southern part of this highly desirable territory. Enzenberg's mission was to assess the possibility of building a good road from Transylvania to Galicia, the value of the land and the attitude of the local population in the case of a future incorporation into the Habsburg Monarchy. After completing his task, Enzenberg informed the emperor that this territory could help protect the Monarchy and thus, if possible, should be claimed (Ceauşu 1998: 52).

The Habsburgs believed the Ottomans would agree to a territorial cession in exchange for Habsburg mediation during the Ottoman-Russian peace negotiations (Heppner 2000: 29). Therefore, a second operation led by the Habsburg officer Friedrich von Mieg, an experienced map-maker, entered northern Moldavia from Galicia and mapped the territory between the rivers Prut and Dniester. The Habsburg ambassador in Constantinople, Thugut, started the negotiations for this piece of land with the help of Mieg's map (Ceauşu 1998: 55). At the same time, Joseph II and his advisors coordinated the cartographic missions with gathering documentary evidence from local boyars or from repositories in Warsaw to demonstrate that the northern part of Moldavia had once belonged to the part of Poland the Habsburg Monarchy had obtained in 1772 (Ceauşu 1998: 52–53).

It is surprising how well the Habsburgs managed to keep their plans secret from the representatives of other European empires. The French representative in Vienna, Abbé Jean-François Georgel, repeatedly wrote to the French foreign minister Charles Gravier count de Vergennes that the Habsburgs were not trying to occupy any part of Moldavia or Wallachia (MAE CP Autriche, 327: 17–19). Moreover, even when Chancellor Kaunitz notified the French Court that his monarchs were claiming the territory of Bukovina, Georgel revealed his ignorance regarding this piece of land and simply mentioned his familiarity with the existence of a forest bearing this name (MAE CP Autriche, 327: 97 verso-98). The French ignorance of Moldavian topography made them unaware of the important strategic advantage the Habsburgs had obtained by claiming Bukovina.

The Habsburg commissaries understood that knowing the accurate geographic situation of their eastern borders gave them the upper hand in the negotiations and stopped other political players from interfering. Therefore, the Habsburgs refused the insistent Ottoman requests to allow the prince of Moldavia, Grigore Ghica, to delegate a commissioner as part of the border demarcation (Ceauşu 1998: 59. In 1775, Ghica had notified the Porte that Bukovina was the richest of the Moldavian lands and that rather than allowing the Habsburgs to occupy it, the Ottomans should ask for help from Russia (Roider 1982: 147–148). However, as Catherine II was distracted by the Pugachev Rebellion (Aksan 2007: 155–156) and the Ottomans had no resources to start another exhausting conflict, the Habsburg and Ottoman commissaries signed the Final Convention of Bukovina's borders on 2 July 1776 (Ceauşu 1998: 58). Joseph II had transformed his territorial claims into reality.

Maps played a key role in the negotiation process between the Habsburgs and the Ottomans, ensuring the Habsburg domination of the northern part of Moldavia. The efforts of Habsburg cartographers from the 1750s to the early 1770s prepared the ground for the Habsburg claims and they also helped support the Habsburg arguments after the occupation of Bukovina. This supposition is supported by a note from 18 February 1777, sent by the State Chancellery to the Aulic War Council. This note states that the extensive reports of Luchsenstein regarding the borders of Transylvania with the Danubian Principalities, together with three of Luchsenstein's maps, had been returned from Constantinople. Therefore, we can assume that the reports and maps had served to support the Habsburg claim regarding the territory of Bukovina and the new border demarcation (HHStA StK, StK an den HKR, Karton 7).

5 Conclusion

For the past few decades, the history of cartography has offered new insights into the formation of early-modern empires, but with some notable exceptions (Hostetler 2001; Kivelson 2006; Seegel 2012), most of the scholarship has focused on the British, French and Spanish Empires (Withers and Mayhew 2011: 446). My paper contributes to this body of scholarship and shows that the Habsburg Monarchy's efforts to mark part of its eastern border can help us understand the role of cartography in helping and even conditioning expansion projects. The marking of the border between Transylvania and the Danubian Principalities during the 1768–1774 Russo-Ottoman war had the clear goal of allowing the Habsburgs to obtain the best strategic positions for themselves, even if that meant infringing into foreign territory. However, Joseph II's decision to annex the northern part of Moldavia was the direct result of the emperor's visit to Transylvania and the map-making operations he ordered in the border areas of Transylvania. Therefore, it is the contention of this paper that eighteenth-century Habsburg maps of the border area between Transylvania and Moldavia did not simply articulate imperial ambitions, but also initiated new imperial expansionist projects.

This paper advocates the need for studying the history of cartography in the eighteenth century in a trans-imperial context. Habsburg plans did not go unchallenged and had to be negotiated not only with the other imperial players in the region (the Russians and the Ottomans) but also with the local inhabitants. Indeed, this paper conclusions accentuate the new direction towards which scholarship in eighteenth-century cartography is heading: moving away from a primarily regional or national scope and towards broader analyses that are more in tune with the global character of Enlightenment mapmaking.

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Exploring and Mapping the Danube: Reading a Hydrographical Map of Buda and Pest (1833)

Zsolt Györö Török and Domonkos Hillier

Abstract The systematic survey of the waters in Hungary started as a late Enlightenment project in the early nineteenth century when hydrographic maps were produced by a new generation of civil engineers. László Vörös (1790–1860), who studied at the *Institutum Geometricum et Hydrotechnicum* (founded 1782), the world's first university-level civil engineering school in Pest-Buda, worked as surveyor, engineer, engraver and map maker for the Danube Mapping Project from 1828. The mapping of the river's section between Buda and Pest became a priority task because of the regular floods threatening the developing and expanding sister cities. Vörös was commissioned to construct a detailed and accurate map from the available topographic and hydrographic data. His large, detailed and elegant map was lithographed by the author and was published in 1833 with the support of the Bridge Builder's Union. Vörös' early thematic map is considered as a milestone in the history of Hungarian cartography and the *Széchenyi Chain Bridge* (1849), a symbol of the Hungarian capital, is the evidence for its contemporary importance. The interpretation of the map's rich data content is very difficult, especially for the modern reader, as it was produced by a specific, hydrographic mapping mode, which cannot be fully understood in the topographic paradigm. In this paper we suggest an historical approach to explore the map's thematic layer and interpret the entire work. By putting this remarkable map into contemporary technical, cultural and social contexts (discourses) its numeric data become meaningful. Modern cartographic visualizations facilitate the interactive exploration of this early map and make it intelligible for the novice or expert map reader. Visualizations of the spatio-temporal database are effective in a cognitively relevant context. In our opinion the successful realization of historical visualizations, beyond knowledge and skills of modern geoinformation technology, require the expertise of the historian of cartography.

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1 Hungarian Waters

On an early nineteenth century map of the Kingdom of Hungary the central part of country, the Great Hungarian Plain, was a huge flat area with abundant hydrography: apart from the two main rivers, the Danube and the Tisza, thousands of smaller rivers, creeks and waterflows, as well as lakes, swamps and marshes indicated the importance of water in the physical geography of the region. In the centuries of the devastating Turkish Wars, vast regions became deserted. After the reoccupation of the territory in the early eighteenth century by the returning Hungarians, other nationalities such as Slovak, German and Romanian settlers migrated here and created a multi-ethnic population with a characteristic settlement pattern of large villages and market towns in the plain. The increasing population and the extending agricultural production required more and more cultivated land. The work the generations of Hungarian civil engineers carried out since the Age of Reforms in the early nineteenth century can be better appreciated if one considers the earlier hydrographic conditions, i.e., the state before systematic water regulations started (Fig. 1).

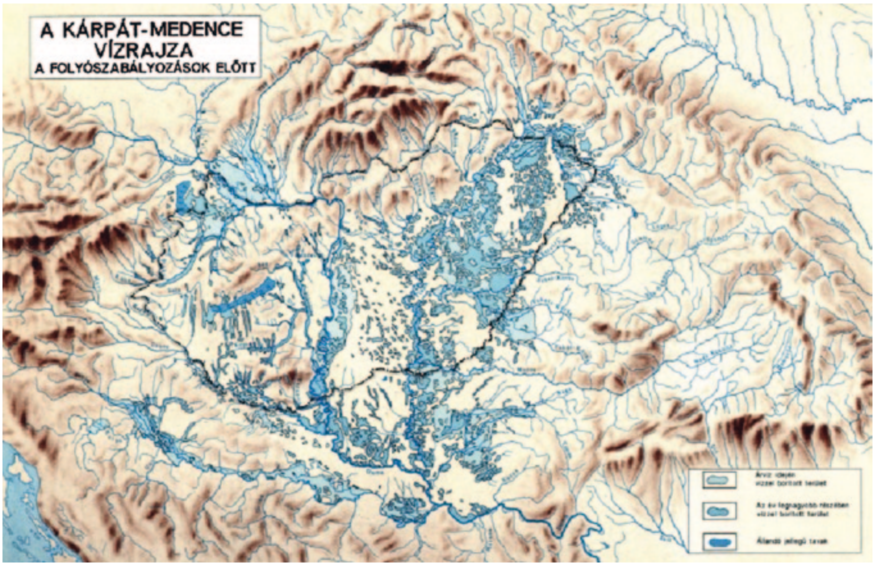

Fig. 1 The hydrography of the Carpathian Basin before water regulations (early nineteenth century) on the map published by the Hydrographic Institute, Budapest, 1938 (*Courtesy* of Department of Cartography and Geoinformatics, Eötvös Loránd University)

2 Enlightenment Cartography in Hungary

The Habsburg government in Vienna realized the importance of water regulations in the modernization of Hungary. The existing maps of the country were unsuitable for planning purposes, so survey and mapping became a priority task already for the first civilian engineer of the Hungarian Chamber.

Samuel Mikoviny, after his studies at the University of Altdorf-Nuremberg and his engineering activity in the capital city of the Kingdom of Hungary Pozsony—Pressburg (Bratislava, Slovakia), was nominated as 'court geometer' in 1735. As the first professor of the mining school in Selmecbánya/Schemnitz (Banska Stiavnica), he was commissioned with the topographic survey and mapping of the counties of Hungary. His pioneer county maps, only partly published, were based on a geometrical and astronomical basis, using triangulation and astronomical observations.

In 1732 Mikoviny published a small booklet, *Epistola*, with the description of the principles of topographic mapping to introduce Enlightenment cartography in Central Europe (Török 2003). The novelty of his new mapping paradigm, how he explains it in his introduction to his maps in 1736, was that his maps were constructed on a measurement and geometrical basis. In the eighteenth century his former students followed in his footsteps, and the more accurate and detailed new maps made the old '*geographical dreams*' (Mikoviny 1735) gradually obsolete. Despite his versatility and continuous occupation with multiple tasks, the priority of water regulation in the period is best exemplified by his fate. In 1750 Mikoviny, at that time the sole civil engineer in the Kingdom of Hungary, worked on the regulation of the river Vág in Upper Hungary (Slovakia), caught a cold during this survey and died on his way home.

By the end of the eighteenth century, the former capital of the medieval Kingdom of Hungary became once again the centre of state administration. This was indicated by a royal decree in 1777 which ordered the Jesuit University founded in Nagyszombat (Trnava, Slovakia) in 1635, to move to Buda. At the relocated Royal University a special department was established in 1782. The *Institutum Geometricum et Hydrographicum* became the first institution in the world for the university level education of civil engineers. After the first years in Buda, the institution moved to a building near to the present University Library of the Eötvös Loránd University, in the city of Pest.

3 Pest-Buda and the Danube Mapping Project

In the early nineteenth century the two sister cities, Buda and Pest were situated on the opposite banks of the Danube, the largest river in Central Europe. Buda with its German population on the hilly side was very different to the Hungarian Pest at the edge of the Great Plain. The two cities were connected by ferries and a temporary boat bridge. Their capacity was, however, limited. With the accelerating development of Pest, where building sites were available, the idea of constructing a permanent bridge became more and more popular.

The rapid development in the first decades of the nineteenth century resulted in more than one thousand new houses, the majority built of wood and air-dried bricks without stable foundations. As the constructions were not water resistant, high water or floods were very dangerous in the densely populated city on the river's left bank. In the past the most devastating were the icy floods, for example the one of 1775, when the level of the water reached its measured maximum of 795 cm above the mean water level. Unfortunately, the raising of the embankment above this level and the blocking of the *Rákos* channel that endangered the suburbs could not solve the problem. From the 1820s onwards several hydrographic experts alerted the City Council that the flood was not only caused by high water. In winter time downstream from Pest-Buda, where the river bed suddenly became wide and shallow, the heavy pack-ice piled up. The ice 'plug' filled the whole river bed and blocked the stream. The river was frozen for 99 days in the winter of 1829–1830, but the water level rose only four metres, because the pack-ice started to move downstream earlier in the southern than in the northern section and, consequently, there was no ice barrier.

Systematic hydrographic surveys of the rivers in Hungary started in the southern part of the Great Plain. After the separate hydrographic maps, constructed by chartered civilian engineers of the counties. *Mátyás Huszár* started the survey of the river Körös in South-Eastern Hungary in 1818. This was a pilot work: Huszár devised methods of the meticulous survey and his reports included detailed practical instructions regarding the complex survey work. He also trained his staff including, among others, the young engineer *Pál Vásárhelyi*, who is the best known representative of nineteenth century Hungarian engineers. In 1822 Huszár was commissioned to direct the hydrographic survey and mapping of the Danube, the famous *Danube Mapping Project* (in German: Donau Mappierung, in Hungarian: Duna Mappáció) (Deák 2009).

4 Lászó Vörös, Carpenter and Cartographer

László Vörös was born in Hódmezővásárhely, Hungary in 1790 in an impoverished noble family with eight children. Due to the large family's financial difficulties he had to work for his living and for years he worked as his father's helper as a carpenter (Bendefy 1974) (Fig. 2).

Although he was a talented boy, he was already 24 years old when he could enrol in the famous College of the Reformed Church in Debrecen. Most probably he became interested in geography and cartography at this time. A decade earlier the students of the college, instructed by the Oxford-graduated professor, *Ézsaiás Budai*, collaborated on the publication of the first Hungarian school atlases, so Vörös could learn the elements of map construction and the technique of copperplate engraving here.

After working as a civil engineer for a short period, he was invited to join the survey staff of *Mátyás Huszár*, and from 1822 he worked as a surveyor on the Körös

Fig. 2 Aquarell portrait of László Vörös painted by György Dongó in 1958 (*Courtesy* Department of Cartography and Geoinformatics, Eötvös Loránd University, Budapest)

rivers. After 2 years of hard word, when Huszár became the director of the Danube Mapping, Vörös followed him. In Pest-Buda he had the opportunity to enrol in the *Institutum Geometricum*, attend the lectures and in the end obtain a degree. In the city he became acquainted with the well-knownt engraver and map publisher *Ferenc Karacs*, who helped and trained him and commissioned him with engraving work to enable him to earn some extra money. László Vörös graduated from the *Institutum* in 1828 and, as a young engineer, was immediately ordered to the Danube Mapping Project. This is the period when he started working on his important thematic map representing the section of the river at Pest and Buda (Török 2007).

After the dangerous floods of the 1820s, the *Governor's Council* realized the urgency of water regulation and flood control and commissioned Huszár and his staff of engineers with the survey. To compile his map Vörös could use earlier maps of the city engineers and he also had access to the survey documents of the Danube Mapping in which he was personally involved. Unfortunately, in 1829 the director of the project was removed and the authorities nominated a new director to the project. Huszár, whose anti-German, patriotic attitude was not tolerated, had to leave just as the great work started to bear fruits. This outcome led to great indignation among his colleagues and students and, to protest against this unfair treatment, Vörös also resigned from his position. The consequences of this noble decision were serious as he could no longer find a proper job where he could use his exceptional talents and his career suffered.

However, as a deputy county engineer he would continue his mapping project and, as an extraordinary case, he not only constructed but also engraved the stones for his large lithographic map. During this difficult period in his life news about the map in preparation reached the circles of the Hungarian Reformist movement in Pest-Buda. Count *István Széchenyi*, fascinated by the modernization of contemporary Britain, was the most prominent representative of this national movement aiming at the development of the country. Now he was already involved in the discussions on the permanent bridge across the Danube and, due to the relevance of the hydrographic map, the count and his circle became interested. In 1832 Vörös published two short reports on the advancement of the map in the journals of the reformists (Vörös 1833a, b).

The reason why his, now private, mapping project generated such huge interest was not just the initial task of flood control, but also the preparations for the construction of a permanent bridge connecting Pest and Buda. Vörös had been working on a map that was needed by the experts and for the public discussion of the possibilities. This explains why the Bridge Construction Society welcomed the Hungarian engineer who was seeking sponsorship. The society, actually a group of investors, became the publisher of László Vörös great work, '*The Topographic and Hydrographic Map of the free Royal Cities of Buda and Pest*', printed in 1833 (Fig. 3).

5 A General and a Thematic Map?

This map of the Danube was the first cartographic work in Hungary which had the newly coined Hungarian word, '*térkép*' (map), a neologism, in its title. In other words, this was actually the first 'map' to be made in this country. As the early nineteenth century is the formation period of modern cartography, the conceptual development the title of Vörös' map reflects, deserves special attention. The author included both '*ground plan*' and '*hydrographic*' as the subjects of his work, suggesting that he clearly realized his work is different from other urban plans or topographic maps of the city (Fig. 4).

At that time, in the first third of the nineteenth century, the modern concept of the thematic map did not yet exist. On the other hand, maps with thematic content and data based on scientific data collection had already appeared much earlier as a typical Enlightenment phenomenon (Török 2006).

Anyhow, in 1832 it was apparently acceptable to both the maker and the public to include rich *hydrographic* content in a *general* or reference map. It should be observed that in the case of this map of Pest-Buda, the additional, special content, the representation of the Danube, did not cause many graphic problems, because the thematic information appeared actually on the river, which was left almost blank on other contemporary maps. Vörös simply used this part of the graphic space to include the vast amount of hydrographic data he collected. The two content layers of his map were *spatially* separated and visual hierarchy was not a design problem.

As the additional thematic content was the result of a hydrographic survey, the *quantitative* data on the map was represented according to the methods of the engineers' plans, and was only meaningful for the professional. This is not surprising

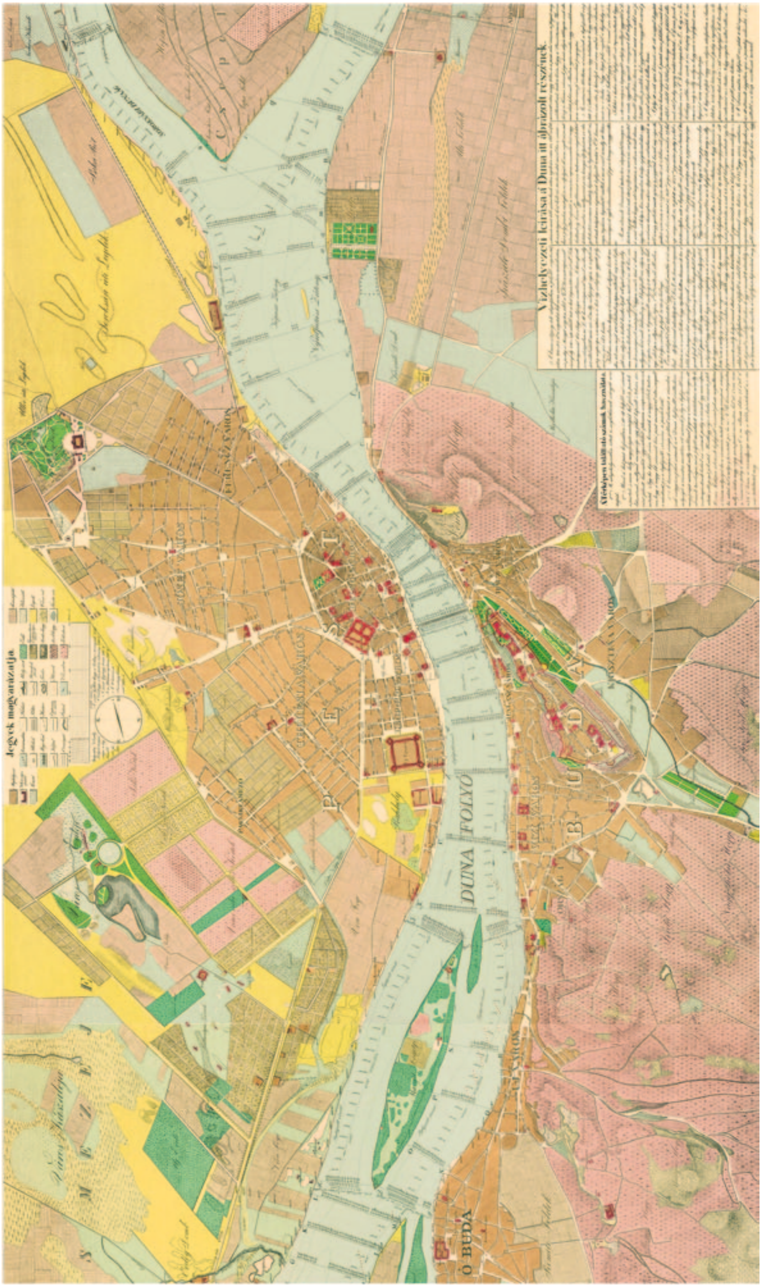

Fig. 3 Detail of László Vörös' map. Pest, 1833. Handcolored litograph. Size: 1745 × 855 mm (*Courtesy* Department of Cartography and Geoinformatics, Eötvös Loránd University, Budapest)

Fig. 4 A reference and thematic map: the descriptive title of the Danube map emphasized its duplicate subjects. Detail of Vörös' 1833 map

since initially Vörös constructed his map for planning purposes, originally for the regulation of the river. After 1829, when he left the Danube project, his task and target group changed and, as we can see above, the map was eventually published for the construction of a permanent bridge.

The usability issue, very rarely tackled in historical context, is neither ignored, but for practical reasons, nor emphasized by the map maker. In his 1833 journal article Vörös proudly refers to the appreciation of the British engineers, who found the earlier version of his map perfectly suitable for *planning* (Vörös 1833a: 373). On the other hand, for the *public*, the average contemporary Hungarian map reader, the data content of the map remained inaccessible. On the other hand, the additional information was highly appreciated and welcomed, as it created the image of professionalism and expertise. The contemporary advertisement of the map mentioned its overall *decorative* function, and the large and handcoloured copies were recommended 'to decorate the walls of palaces and libraries' (Kaján 1988: 54) (Fig. 5).

The fine lithography is still considered as a highly decorative item, and in 1986 its colour facsimile was published by Földmérési Intézet. Among the known copies of this rare work there is a remarkable example, today preserved in the collection of the *Danube Museum*, Esztergom. The information about its previous ownership by the Director of the former Hydrographic Office in Budapest in the first half of the twentieth century suggests that this was a special, presentation copy. The original letter in the archives of the Danube Museum, written by Vörös in late August 1832 to Count Széchenyi refers to a special copy of the map, sent to Széchenyi as gift immediately after publication. When we inspected the map in the museum we discovered the blind stamp of László Vörös in the bottom left corner, which is the evidence that this print was approved by the maker. It is not entirely speculative if we consider the possibility that the map which is now in the museum's collection

Fig. 5 Dr András Deák in front of the presentation copy of the 1833 map in the Danube Museum, Esztergom, Hungary. Photo by Zsolt G. Török

could once have been owned by Count Széchenyi. It is interesting to mention in this context that the same copy was used to decorate Count Széchenyi's study in the Hungarian film '*Bridgeman*' (2002), a biography of Count Széchenyi.

Vörös well understood the problems of his map's interpretation. In the bottom right corner of the map he placed a longer explanation, a detailed description of the map's content. Although written in Hungarian, the interpretation of the professional terms is rather difficult for even the modern Hungarian expert. Since the publication of the map we not only use the metric system, but, as the nineteenth century methods of survey and mapping are no longer in use, without the historical context it is really difficult to understand the conceptual framework. Although the map includes a vast amount of *quantitative* data, which make it especially suitable for modern geovisualization and analysis, without the knowledge of the historian of cartography these cannot be interpreted. The map calls for this kind of expertise which is necessary to establish the geodetic datum used by the author. Without knowing the reference system, the georeferencing of the map remains impossible. This explains why we used modern visualization methods to make both the base map and the thematic layer of this old map available for modern readers only after the study of the map and the contexts of its creation.

6 Historical Cartographic Visualization

The visualization of *historical data* is different from the generally known methods of cartographic visualization. In the case of early maps the problem is how to provide modern map readers with a historic view, as we want them to be able to interpret events or processes in the past. Compared to static cartographic displays based on a database, interactive or web visualization offer many more opportunities for the examination of historical data in a cognitively relevant context. Due to the users' interactive collaboration with the system, the possibilities are theoretically endless.

On the map of László Vörös the most important and immediately striking feature is its extraordinary rich data content. The large scale of the map, the origin of the data and the aim of the map all resulted in much quantitative information, which makes the work especially suitable for building a relational database and modern, computer based processing and display.

The most difficult problem was the, nowadays, unusual height representation. Vörös did not use our modern reference system, but a totally different representation of heights or depths (Bendefy 1958). He adopted an arbitrary level and from this level he would calculate his values. Moreover, the depth of the water is given in non-metric units (fathoms). Before designing cartographic visualizations, we had to georeference Vörös's map, which was not a simple task. The map has no information regarding its projection, only a scale is given. Starting from its numeric scale (1:7,200) we considered several possibilities. In the end we arrived at a known, and amongst nineteenth century hydrographers a rather popular projection, the Cassini-Soldner projection. Using its characteristics to georeference the map, we reached an accurate result with a mean positional error of c. 10–20 cm.

The GIS data processing and data clustering raised special problems, as we had to answer more difficult questions regarding the datum the map maker used, and solve technical problems regarding the handling of huge image files. The preparatory work summarized above was indispensable for the construction of the coherent database, and as a result we created the next four different visualizations which we introduce below.

7 Time Travel with a Nineteenth Century Map of Budapest

The visualization of the map with the use of the Google Earth webpage plug-in first of all emphasizes visual power and propaganda. This visualization actually compares Vörös' map with the urban conditions of today. On the known map and satellite image, after turning on the 3D buildings layer, the changes of the river (Danube) and the transformation of the built-in area in the last one and half centuries are well demonstrated.

When viewing the Southern Buda area (today Lágymányos) and the present location of the campus of the Eötvös Loránd University, a dramatic change visible. The causes of the transformation of the riverbed were river control and the embankment of the city. With this technology, with Vörös' map on a separate layer, we can show modern buildings and the present road network. The two points of temporal reference are 1833 and 2012. With this visualization the two dates can be shown simultaneously, and the river changes appear spectacularly, while the differences can be easily monitored. The interactivity of the visualization is made possible by the usual Google Earth navigation options, and also by the additional thematic layers, integrated into the webpage. With custom buttons on the webpage one can turn on and off layers, e.g., the terrain model, the road network or the three-dimensional visualization of the buildings. This application is prepared for the general public; the old map as a layer on the virtual globe provides a unique viewing experience for all those interested (Fig. 6).

8 Visual Analysis

Different considerations led to the creation of another, also Google-based visualization. The aim of this realization is that the previously interpreted and GIS software processed riverbed and other data are present in vector format in an easy-to-understand way. This visualization opportunity focused on detailed data display, for deeper understanding and exploration of the more detailed information. Perhaps it is less spectacular than the previous one, but it could seriously assist the specialist to interpret the contents of the map, and provides an effective tool for visual analysis.

On the original cartographic document there are heights, water depths and additional hydrographical data. These data classes were classified first and in this interpreted form displayed in the system. The vector data structure of point, line and surface objects are all related to attribute data. With the interpreted information the content of the display expanded. As a result of data clustering, their high accuracy, the different data types are marked with different graphic objects. The graphics are

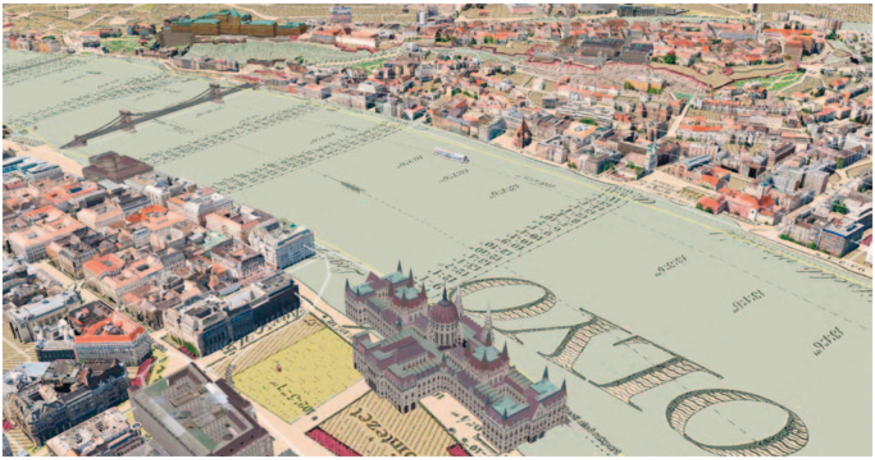

Fig. 6 The House of the Hungarian Parliament in the 1833 riverbed. Visualization of the 1833 map in Google Earth with the 3D layer of modern buildings

simple and clean, so the detailed old map's content is much easier to overview, and it can be used for spatial analysis purposes. Overall, this display option enhanced the early map's decision support functions, so that it can be used for similar current purposes.

9 Comparison of the Former and Present States

The integrated study of an old map and a present satellite image of the same area enhances the potential for visualization. The third method for visual exploration of László Vörös's Danube map is a Flash-based, interactive visualization. This is different from the former two network solutions as it operates independent from the Internet and uses only internal programmed and generated files. The essence of this animated display is that the former and present state of the same geographical point can be easily compared, and so the changes can be clearly followed. In the visualization we took the original map and a modern satellite image and put them on precisely matching layers. The comparison is facilitated along a horizontal line separating the two images. The position of the line can be changed interactively so the two images can be compared. This display is good for illustrating or monitoring the changes and the detection of a casual relationship. This technique is suitable for any representation of spatially well-defined historical topics. The spectacular visual application's possibilities are wide-ranging (Fig. 7).

Fig. 7 Spatio-temporal comparison of the 1833 map and the 2012 satellite image. The detail with the city of Budapest demonstrates changes as well as the accuracy of the georeferencing

10 Virtual Terrain Model

From the visualization described above the opportunities offered here are significantly different. Compared to the previous display, the creation and application of Vörös's map's 3D terrain model-based display was a much more complex and complicated task. The map contains three-dimensional data for the 1833 Danube river bed. We created a display to demonstrate the former state of the Danube in the section covered by the map with the help of a terrain model. After the lengthy data-processing of the linear elements delimiting the riverbed, a TIN model was made from the point-cloud representing the Danube. Next a DEM model was created for improved visualization.

This model depicts the state of the riverbed of the Danube in 1833 on the basis of the cross-sections and other points measured. Information is limited to the riverbed because we had no contemporary relief information about the cities, so in the 3D model we used current data (ASTER). The texture placed on this model was taken from the raster image of the original early map. After the necessary vertical exaggeration, from the complete three dimensional data an interactive model was made for the general public. The data has been converted into a VRML model and with the help of a plug-in this can be viewed in a web-browser. Using the viewer's function, the model can be enlarged and rotated as best suited to the user. Perspective views can be created interactively with the tools of modern cartography. By getting the user involved in this process he/she can study a map or 3D model made by himself/herself.

11 Conclusions

László Vörös's printed, large scale thematic map of 1833 is a detailed and accurate depiction of the topography of the contemporary cities, Buda and Pest, but it also a summary of the hydrographic-hydrologic survey of the river. Although the importance of the map has long been recognized, the analysis and the interpretation of its content only became possible through the adoption of the historical approach suggested in this paper. The map is interpreted in the technical and historical contexts of its creation, especially in the frame of the *discourse* on the construction of a permanent bridge connecting Buda and Pest. To visualize the database a series of different historical visualizations were created, each of them facilitating an interactive visual exploration of the maps' information and data content in a *cognitively relevant* spatio-temporal context. The applied visualization methodology, rarely used in conjunction with historical cartography, provides new possibilities for the interpretation of historical maps for both specialists and novice users.

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Saxony's Role in the Measurement of the Central European Meridian Arc as an International Geodetic Project Since 1862

Jana Moser

Abstract In 1861 the Prussian officer, Johann Jacob Baeyer, in his memorandum "Ueber die Größe und Figur der Erde", developed a vision for the measurement of a meridian arc in central Europe. According to him, such a measurement would contribute to the existing knowledge of the dimensions of the earth. Although Prussia and Saxony had been arch enemies for centuries, the Saxon State Ministry decided as early as 1862 that they would take part in the measurement. At this time there existed a relatively accurate triangulation of Saxony which had been completed by Friedrich Ludwig Aster between 1780 and 1825. Although this survey formed the basis for the well-known Saxon topographic maps called Meilenblätter (mile sheets), the relevant triangulation points had not been marked permanently and could therefore not be verified or used for re-measurements. By 1862 the responsible parties realised that the meridian arc measurement could also be used as a basis for exact triangulation, which meant that it would be possible to also use it for better topographic map material (Messtischblätter/Ordnance survey map). The central European project—the first scientific cooperation within Europe—quickly developed an international dimension which can be regarded as the predecessor of today's International Association of Geodesy (IAG). It was also one of the first projects of international cooperation in the field of surveying. Christian August Nagel, one of the Saxon protagonist's and the person responsible for the measurements of both the meridian arc and of the triangulation, was a member of the Commission for International Meridian Arc Measurement. This meant that Saxony's participation in the project was, right from the beginning, integrated in an international context. To honour this agreement, the year 2012 which marks the 150th anniversary of the beginning of the central European meridian arc measurement, has been celebrated in Saxony with an exhibition and a conference.

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1 The Jubilee

The year 2012 marks the 150th anniversary of the Kingdom of Saxony's initial joining of the central European meridian arc measurement in 1862. In 1861, the Prussian officer Johann Jacob Baeyer (1795–1885), presented an exposé "Ueber die Größe und Figur der Erde" (About the Size and Form of the Earth) which can be regarded as a first step in the international collaboration in Geodesy specifically, and Science in general. In 1862 Saxony was one of the first countries to join the project. With its three well known commissioners Julius Ludwig Weisbach (1806–1871), Carl Christian Bruhns (1830–1881), and Christian August Nagel (1821–1903), Saxony took a leading role in the maintenance and development of this newly-developed international organisation.

2 Starting Situation

2.1 Form and Figure of the Earth

The true shape and figure of the earth have interested scientists since ancient times. Amongst scientists of antiquity, Homer (about 700 BC), Eratosthenes (about 200 BC) and Ptolemy (about 200 AD) all considered this question. That the earth is a sphere has been known from early on. In the second half of the seventeenth century some scientists established the theory of an oblate spheroid. This theory is based mainly on studies of gravitation, and the theory of balance of rotating figures by Isaac Newton (1643–1727), as well as the measurement of pendular movements which were made by the astronomers Giovanni Cassini (1625–1712) and Jean Richter (1630–1696) at different places on the globe.

The introduction of the method of triangulation by Snellius (1580–1626) in 1614/1615 launched an effective technique for the measurement of the shape of the earth. In 1669/1670 a measurement along the Paris meridian was realised. The results caused intense controversy in the scientific community about the real shape of the earth and the question whether the earth was tapered or flattened at the poles (orange vs. lemon). To solve this question, the French Academy of Sciences sent two expeditions for meridian-arc measurements: one to a region in the high latitudes in (Lapland 1736), and another to a region situated in the low latitudes (today's Ecuador 1736–1743). The results provided by these expeditions proved the oblateness of the earth. Today these studies can be looked upon as the beginning of international cooperation in this field as the fact that scientists from different countries took part, stressed the fact that there was also a need for political agreement between the affected states (Torge 2012: 6) (Fig. 1).

The oblateness of the earth was later also proved by other measurements. One of these was the survey of western Russia which was initiated by Wilhelm Struve (1793–1884). The Struve Arc stretches from the Arctic Sea to the Black Sea, was

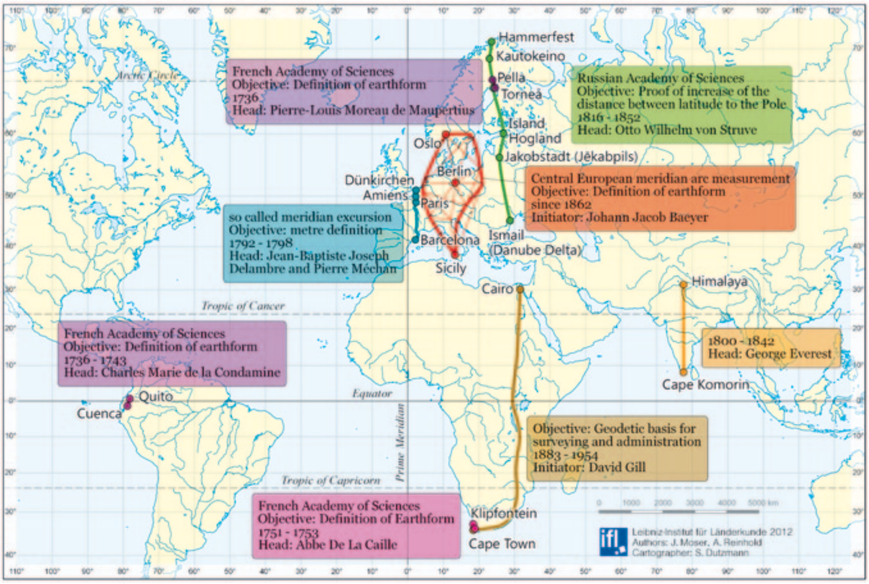

Fig. 1 Important meridian arc measurement expeditions in the eighteenth and nineteenth centuries

surveyed between 1816 and 1852, is more than 2,800 km long, and spans more than 25 degrees of latitude.

In 1829 Russia suggested that the Struve chain should be joined with the German chains via East Prussia in the Baltic area. Friedrich Wilhelm Bessel (1784–1846), director of the Königsberg observatory, supported the plan because of its relevance for the study of the shape of the earth and was assigned to run the project between 1832 and 1836. He developed a new instrument for the measurement of baselines which was named after him and which would be used in decades to come. In 1841 Bessel calculated a spheroid from ten different meridian arc measurements—the so-called "Bessel spheroid" of 1841. After this achievement, the measuring of meridian arcs to determine the size of the earth became less important. What remained important was the question of the true shape of the earth and the need to measure large chains in order to obtain a basis for ordnance surveys.

2.2 Mid to End Nineteenth Century Saxony

The Kingdom of Saxony was established in 1806 from the Prince Electorate of Saxony. In the treaty of Vienna 1815 the Kingdom lost almost 2/3rd of its territory, and less than half of its population (Stams 2007: 18–36). After the defeat by Prussia in the German war of 1866, Saxony joined the North German Confederation under

Prussian leadership. Despite the political enmity between Prussia and Saxony, this step led to an increase in scientific cooperation and a joint action in the field of military development. Since 1871 Saxony has been part of the German Reich.

During the long nineteenth century which effectively lasted from the French revolution until the beginning of World War I, Saxony developed as a sophisticated political, economic and social entity. Politically the country oscillated between neo-absolutism and liberalism. Since the 1820s the German liberal movement was strong in Saxony with the result that various political parties were founded. The elite which harboured strong anti-Prussian resentments also obstructed the identity change of large parts of the population from Saxon to German. Economically Saxony was one of the leading German states with well-developed textile, engineering, metal processing and mining industries. Black coal was mined, iron and steel were produced, and by the end of the nineteenth century new industries such as precision engineering and optics were established. The possibilities this opened for the quality of surveying instruments would have a lasting effect on all geodetic and land surveys since the 1860s.

During the 1860s industrial production in Saxony overtook traditional craft production. This created a new social class, the working class. However, no other country in Germany had less workers in the agricultural sector than Saxony (less than 20 %), and the production conditions were also underdeveloped at the time. At the same time the Kingdom was one of the leading German states in infrastructure building—especially in railroad construction. As early as the 1850s there were international railway connections from Dresden to Paris and to St. Petersburg. The regional expansion took off in the 1870s. As a result, spatial cognition was modified (distances shrunk), and new products reached Saxony and influenced the price structure. Saxony had the highest income per capita, but struggled with serious social problems caused mainly by demographic growth and urbanisation.

2.3 Surveying and Mapping in Saxony up to 1830

Like Prussia and Bavaria, Saxony had a solid cartographic foundation since the beginning of the nineteenth century. During earlier times, different recordings were made. Survey for mapping purposes took place before the Thirty Years War (1586–ca. 1618) when the Prince Elector instructed the mapping of his territory for administrative reasons. Apart from numerous small-scale maps issued from the seventeenth and eighteenth centuries, Adam Friedrich Zürner (1679–1742) executed a geographical survey at the beginning of the eighteenth century. As a result, maps were made (Fig. 2) and later modified and published by Peter Schenk (*Atlas Saxonicus novus*). The milestones which were erected along the streets are well-known until today.

In the eighteenth century the military developed rapidly. Maps became more and more important for planning and the realisation of military operations considering terrain conditions (visibility, slope, soil type, vegetation). The needs for organisational change were met by the establishment of the Saxon engineering

Fig. 2 Two segments of manuscript maps of Saxony. *Left* by M. Öder, ca. 1600, section reduced (Bönisch 2002, H 4.1; Sächsisches Staatsarchiv—Hauptstaatsarchiv Dresden, 12884, Schr. R, F. 1, Sekt. XIV). *Right* by A. F. Zürner, ca. 1720, section reduced (Sächsisches Staatsarchiv—Hauptstaatsarchiv Dresden, 12884, Schr. 001, F. 013, Nr. 010A, sheet 007)

corps in 1712 and the engineering academy in 1743. The training for the officers included surveying, topographic mapping, and the drawing of schemes (Brunner 2005: 5). At some stage they were also trained to identify morphological features in the landscape, and to draw relief features.

One result of the Seven Years War (1756–1763) was an increasing demand for maps for military and administration objectives with the result that a new survey was ordered by the Prince Elector Friedrich August III (1750–1827). In 1780 the Saxon engineering corps began to prepare for an accurate map series based on a trigonometric survey. The map orientation was determined by the base measurement which caused a rotation of about 43° with reference to geographic north (Fig. 3).

The square maps were based on the Saxon measuring unit known as the "small Saxon mile" which consisted of 12,000 ells which were reduced to one ell. The map scale was consequently 1:12,000 and one sheet depicted an area of one square mile. This gave the maps the name "Meilenblätter" (mile sheets). Because of the military importance of the project, the maps were produced as manuscript maps only and today exist in three copies. The original of 547 sheets were available for the engineering corps (known today as the "Dresden copy") only. Until 1813 all of the then produced 371 sheets were copied for the Prince Elector (later King) of Saxony, but then fell into Prussian possession. Today these sheets which are preserved in the Berlin State Library, are known as the "Berlin copy". A second copy was later made from selected sheets for the mining office in Freiberg (Saxony) for geological records. This so-called "Revierkopie" (mining district copy) is today known as the "Freiberg copy", named after the Saxon State Archives department in Freiberg where they are kept (Brunner 2005).

The Dresden and Berlin copies originally looked similar, but the Freiberg copy was made later and with a different terrain illustration. Today only the Berlin version

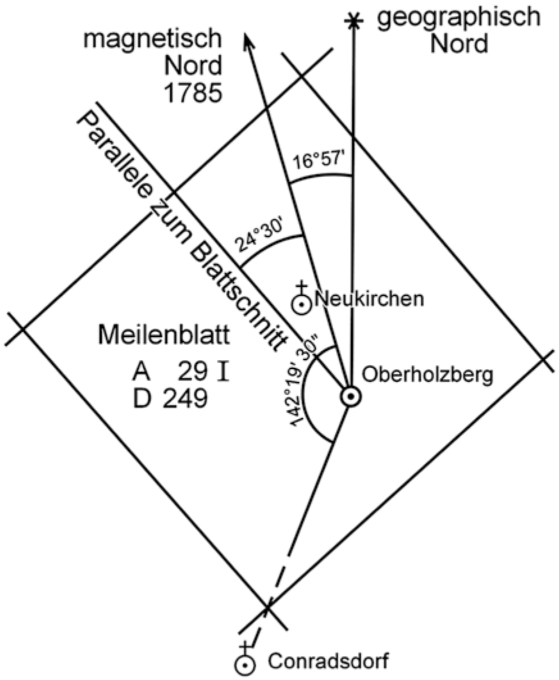

Fig. 3 Rotation of the Meilenblätter depending on the position of the base line measurement (Brunner 2005)

shows the original landscape as it was at approximately 1800, as the Dresden original was later used for supplements. All copies exist as manuscripts only.

3 Project Call and Surveys

3.1 Project Call

The Meilenblätter provided Saxony with a reliable topographical map series. In the nineteenth century further activities concentrated on cadastral mapping with no further plans for triangulation. In contrast to this, other states such as Prussia undertook numerous triangulations all over their territory which were then connected piecemeal. As in Saxony, the main problem was the permanent protection and maintenance of the triangulation stations (Torge 2009: 167).

In 1857 Johann Jacob Baeyer (1794–1885) (Fig. 4) was dismissed from his military career after which he concentrated on the question of the figure of the earth. He previously was employed by the Prussian military staff and as such was responsible for the triangulation undertaken in East Prussia. His cooperation with Friedrich Wilhelm Bessel, the head of the Königsberg observatory, significantly influenced Baeyer, and his later success can be ascribed to the fact that he succeeded in combining his military way of thinking and methodology with the

Fig. 4 *Left* Johann Jacob Baeyer (1794–1885) (Buschmann E (ed) Aus Leben und Werk von Johann Jacob Baeyer. Frankfurt/Main, 1994). *Right* Friedrich Wilhelm Bessel (1784–1846) (Torge 2009: 161)

scientific approach of Bessel. As could be expected, this resulted in an increased scientific penetration of the originally military surveys (Torge 2009: 160–164).

In April 1861 Baeyer presented his exposé "Ueber die Größe und Figur der Erde" (Fig. 5) to the Prussian War Office. The aim of this project was the measurement of a meridian arc which would consist of a number of interconnected trigonometric surveys and would stretch from Christiana near Oslo in the north, to Palermo in Sicily in the south. After Bessel's spheroid calculation, the central issue was not the size, but the real shape or figure of the earth. By involving numerous observatories in Europe to undertake astronomical surveys and observe gravity differences, the problem of plumb-line deviation could be surveyed more accurately (Baeyer 1861).

On 20 June 1861, only two months after the submission of his exposé, Baeyer's project was authorised by a royal cabinet order. The Prussian state was apparently very interested as the Prussian foreign ministry shortly afterwards requested various European governments to participate.

The first preliminary discussion took place in Berlin in April 1862, one year after the exposé. Besides Baeyer, who acted as the representative of Prussia, commissioners from Austria and Saxony also took part. The parties involved reached an agreement on the date the survey would begin, the use of older triangulation chains, the way base-line measurements would be done, the method of measurement, and the connection of the triangulations between the different countries. This conference can be considered as the first step in undertaking the central European meridian arc measurement. Apart from Saxony and Austria, thirteen other European countries joined the project in the same year.

3.2 Saxony Joins the Project

Since the beginning of the nineteenth century Saxony had two main surveying authorities with different objectives—a military, and a civilian. The military authority was responsible for land survey and topographic mapping. In 1856 the

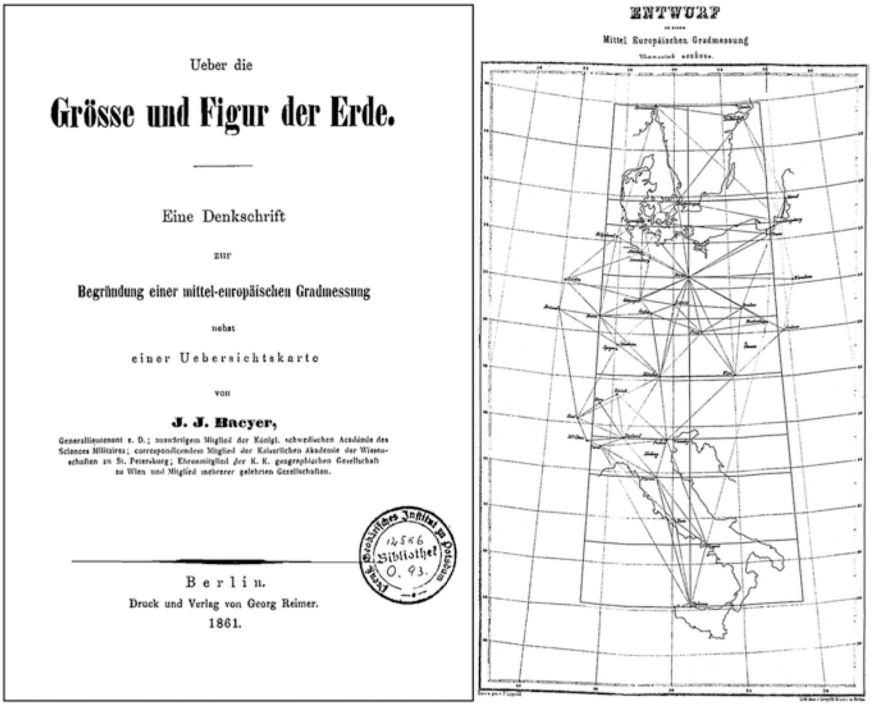

Fig. 5 Title page and outline of the central European meridian arc measurement by Baeyer (1861)

"Military plan records", founded in 1806, was renamed the "Topographic Bureau" and annexed to the Saxon General Staff. The civil authority, on the other hand, was responsible for cadastral mapping.

Prussia's call to join the project reached the Saxon Ministry for Foreign Affairs on 12 July 1861. The Saxon War Office, which was asked first, initially refused the proposal because those responsible recognised it as a purely scientific project of no military interest. The Ministry of Finance, however, realised that it was a good opportunity to also meet Saxon interests. In Saxony there was an urgent need for a new property tax survey, and Saxony was also well equipped with qualified personnel and resources. Furthermore, there was the possibility to obtain new cartographic material. The Meilenblätter and the derived topographic maps were good, but there was no chance to locate the 1780 triangulation, and the rapid infrastructural and demographic development in the mid-nineteenth century necessitated a new survey.

The Ministry of Finance was willing to bear the costs and proposed three civilian scientists to conduct the work: Julius Ludwig Weisbach (1806–1871), mine surveyor, mathematician and professor at the Bergakademie Freiberg; Carl Christian Bruhns (1830–1881), astronomer, director of the Leipzig observatory and professor at Leipzig University; and Christian August Nagel (1821–1903), surveyor and director of the Geodetic Institute of the Royal Saxon Polytechnic in Dresden (Fig. 6).

Fig. 6 Julius Ludwig Weisbach (1806–1871), Carl Christian Bruhns (1830–1881) and Christian August Nagel (1821–1903) (Landesvermessungsamt Sachsen (ed) (2006) Die Vermessung Sachsens. 200 Jahre Vermessungsverwaltung. Dresden: 59, 37, 15)

The appointment of these eminent scientists had the advantage that all three brought along the required equipment, especially the high-precision instruments, used in their respective working environments. The main Saxon demand was to realise the meridian arc measurement in such a way that the trigonometric points and results would be directly usable for the ensuing Saxon land survey (Nagel 1876). The Prussian call was therefore positively answered and the three Saxon commissioners already participated in the preliminary meeting in Berlin in April 1862.

By the end of 1862, sixteen European countries had joined the project. It was already clear at the preliminary meeting that the survey would have a high relevance for the Kingdom of Saxony. The time around 1860 was like an interim without wars or conflict. Politically it was, however, not a quiet period and Saxony and Prussia were not on a friendly footing. The prompt reaction of the Saxon authorities and the widespread participation of other countries were, however, strong signs of the general need for scientific collaboration despite political differences.

3.3 The Meridian Arc Measurement in Saxony

The meridian arc measurement project consisted of different parts:

- The **triangulation** was to be executed in such a way that all angles were measured as part of a network (Fig. 7). The key factor for the central European project was the overlapping of the work done by the various states, the coordination of this network, and benchmark connection.
- During the **base line measurement** the length of one line had to be accurately determined. Using the scale of the triangulation network, the length of all other triangle sides and the coordinates of the benchmarks could then be calculated.
- **Astronomical observations** were necessary for latitude and longitude definition.

- With **pendulum measurements** the acceleration of gravity had to be observed to obtain information on the exact shape of the earth.
- In 1864 the participating countries agreed to also conduct a **geometric levelling** for height measurement.

The concept of the work which had to be carried out in Saxony was collectively developed by the three Saxon commissioners. For practical reasons they decided to divide the work: Weisbach was responsible for the geometric levelling, for the base line measurement administration, the calibration of the base line instruments and the building of the benchmarks. As the longest-serving under the commissioners, he also had to administer the commission's general affairs. Bruhns took over the astronomical and pendulum observations. Nagel was accountable for the triangulation network and the local preparations for the base-line measurements. Adhering to this division of work, they hoped to complete the meridian arc measurements above and beyond their "normal" workload as professors and scientists.

Without going into detail, the main results of the survey should be mentioned. In Saxony 36 first order benchmarks were established and safely fixed on the ground (IG and GeoSN 2012). Most of the artistic stone pillars which were erected still exist, although not everywhere in the original positions, and are now considered cultural monuments. The base-line measurement near Großenhain was of an exceptionally high precision as the error for the distance of 8,908.646 860 metres amounted to only ±7.13 mm. The geometric levelling resulted in 875 points with height determination in comparison to the mean sea level near Swinemünde (Baltic Sea) and the normal mark of the Prussian ordnance survey in Rauenberg near

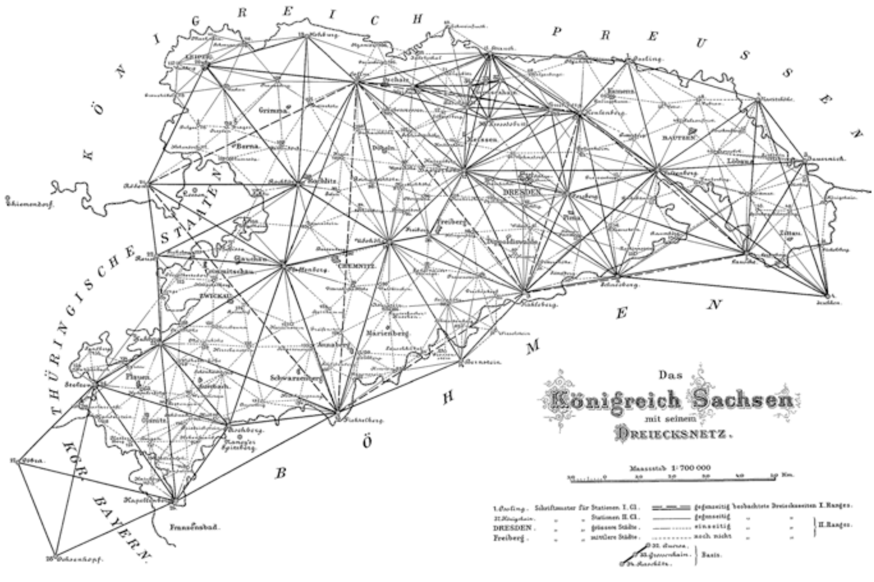

Fig. 7 Outline of the Saxon first and second-order triangulation network (Nagel 1890)

Berlin. The astronomical observations framed the Saxon triangulation network. Longitude difference measurements in relation to foreign observatories guaranteed the connection to the neighbouring meridian arc measurements. The coordinate calculations were made according to the formulation by Johann Georg von Soldner (1776–1833). The most important improvement in comparison to the earlier surveys was the solid and long-lasting marking of the benchmarks.

3.4 The Following Ordnance Survey

The Saxon authorities were mainly interested in obtaining a new ordnance survey. They wanted the new survey to be an exact triangulation network which could be used for military and public, as well as economic purposes, for infrastructural planning and building operations, and for new topographic maps, but also as basis for cadastral surveying and large-scale town mapping.

The main procedure had to be the same as for the meridian arc measurement. The first order benchmarks were the basis for the second-order network which densified the first-order one. The distances between the first-order points were approximately 50–70 km and, for the second-order points, about 20–30 km. Supplementary to the first-order points, 122 order points were fixed. All angle measurements were made with one instrument, a universal Repsold theodolite. Nagel, who was responsible for this, conducted all readings himself. He strictly followed the rule "one instrument one observer" to minimise potential errors. The nearly 40,000 observations carried out by him affected his eyesight to such an extent that he was blind in one eye until the end of his life. He had also two clerks with him to note the observations and to re-check the written results. All calculations were made by Nagel himself during the winter period. Because Nagel was responsible for all tasks, evaluations and publications after the death of Weisbach (1871) and Bruhns (1881), the observation pillars of the first and second order triangulations are today known as "Nagelsche Säulen" (Nagel's pillars) (Fig. 8).

4 From Mile Sheets to Plane Table Sheets—"New" Topographic Maps

One reason why Saxony joined the central European meridian arc measurement project was the possibility to obtain new maps for administration, planning and military purposes. The usual problem with such projects is the long time it takes to complete them and that mapping can only begin after the different survey levels and the coordinate calculations have been done. The survey work in Saxony began in 1862, and the levelling in 1865. The results were published in 1890. The topographic plane-table mapping, which was also undertaken, commenced in 1898. As already mentioned Saxony possessed reliable cartographic material in the form

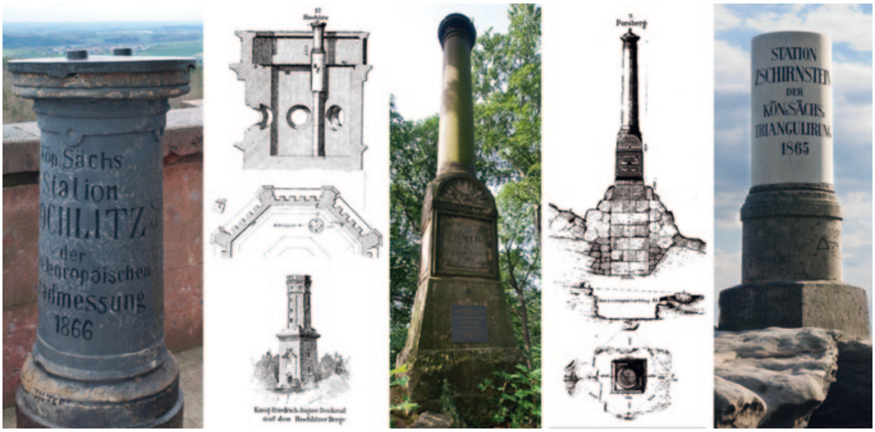

Fig. 8 Three examples of "Nagelsche Säulen". *Left* 1st order station Rochlitz with building and marking sketch. *Middle* 1st order station Porsberg (today Borsberg near Dresden) with building and marking sketch. *Right* 2nd order station Zirnstein (Saxon Switzerland)

of the mile sheets. However, since 1800 the local demographic and infrastructural development necessitated that new maps should be compiled before the start of the plane table survey. The development from the mile sheets to the plane table sheets can therefore only be understood as a process of removal.

The mile sheet series had its origin in the Saxon ordnance survey between 1780 and 1825. The resulting maps were made as manuscripts to be used by the army and the Prince Elector/King. There was, however, also an urgent need for maps for administration purposes. In 1819 a printed map series on a smaller scale was ordered by the King. The "Topographic Atlas of the Kingdom of Saxony" which consisted of 22 sheets, was made using copper engraving on a scale of 1:57,600 by Jacob A. H. Oberreit (1777–1856), and was published between 1836 and 1860 (Fig. 9, right).

The so-called Oberreitscher Atlas was again the basis for the first Saxon map with degree sections. The "Topographic Map of the Kingdom of Saxony" on a scale of 1:100,000 was prepared between 1861 and 1873, especially for military purposes.

In 1870 the Saxon geological survey decided to undertake a geological survey. The lack of a reliable topographical map series which covered the entire country on a scale of approximately 1: 25,000 was obvious. As the completion date of the meridian arc and ordnance survey measurements could not be predicted, the mile sheets had to be again used as basis for a new topographic map series. In a similar way as for the production of the Oberreitscher Atlas, the Dresden original of the mile sheets was revised. Supplementary information such as new railway lines, roads, and buildings were added to the original manuscript sheets. The results of the levelling were also marked on the sheets and, from these, and the cross shading, contour lines were interpolated. These revised sheets were directly used for the production of a map series called Äquidistantenkarte (map with contour

Fig. 9 *Left* Meilenblatt Berlin copy B187, 1800, original scale 1:12,000—section reduced and rotated (Staatsbibliothek zu Berlin–Preußischer Kulturbesitz, Kart. M14433). *Middle* Meilenblatt Dresden copy D226, 1800 with later supplements, original scale 1:12,000—section reduced and rotated (Sächsisches Staatsarchiv–Hauptstaatsarchiv Dresden, 12884, Schr R, F 012, Nr 226). *Right* Oberreitscher Atlas, sheet IV, 1858, original scale 1:57,600—section enlarged, derived from the Dresden copy Meilenblatt (Sächsische Landesbibliothek–Staats- und Universitätsbibliothek Dresden, SLUB/KS 8130)

Fig. 10 *Left* Meilenblatt Dresden copy D226, 1800 with later supplements, original scale 1:12,000—section reduced and rotated (Sächsisches Staatsarchiv–Hauptstaatsarchiv Dresden, 12884, Schr R, F 012, Nr 226). *Middle* Äquidistantenkarte, sheet 49, 1882, directly derived from the Dresden copy Meilenblatt. *Right* Messtischblatt, sheet 49, 1911 (both sections: original scale 1:25,000—reduced; Sächsische Landesbibliothek–Staats- und Universitätsbibliothek Dresden, SLUB/KS 15307 and SLUB/KS 15316)

lines of same height, Fig. 10, middle) on a scale of 1:25,000. The map prepared between 1870 and 1884 followed the Prussian Messtischblätter in scale and sheet line system (6' by 10'), but were based on the older Saxon coordinates which were measured prior to 1830 and which were used in the Oberreitscher Atlas.

It was only after the publication of the triangulation results and coordinates in 1890 that a new topographic survey could start in 1898. Based on a plane table survey, a new map series was prepared. In 1904 the first Messtischblatt on a scale of 1:25,000 was published. The sheet line system was the same as on the Äquidistantenkarte. Using the "Bessel spheroid 1841" as reference system for the geographical grid resulted in a significant shift in the length and width of the maps (up to 400 m in nature, Fig. 11). Until 1911, Saxony still used the Ferro meridian as the prime meridian, but the later editions used the Greenwich meridian. This change did not result in a shift in sheet lines.

Fig. 11 Map comparison with regard to sheet lines, prime meridian and coordinates, as well as graphic representation. *Left* Äquidistantenkarte, sheet 49, 1882. *Middle* Messtischblatt, sheet 49, 1911. *Right* Messtischblatt, sheet 49, 1922. All sections: original scale 1:25,000—reduced (all: Sächsische Landesbibliothek–Staats- und Universitätsbibliothek Dresden, SLUB/KS 15307; SLUB/KS 15316; SLUB/KS 15325)

Another obvious difference between the Äquidistantenkarte and the Messtischblatt was the different graphic representation (Fig. 11). Both series were printed in three colours. Indeed, the Äquidistantenkarte was prepared using the Saxon specification which called for less differentiation between transport routes and a one-line representation of most roads. The new Messtischblätter were based on Prussian specifications which resulted, amongst others, that roads were shown as double lines with more differentiation, and that urban places seem denser, due to the hatching of gardens. The number of contour lines is also much higher (due to a smaller contour interval) with the result that the many lines and symbols seem to clutter the map. Although Saxon users were not very satisfied with the new design, the Messtischblätter are still in use today for historical but also for planning purposes because of their good morphology and detail.

5 International Cooperation

Whilst calculating the East Prussian meridian arc measurement, Bessel noted a marked variance in the real form of the earth in comparison to the hypothetical ellipsoid. The intense cooperation between Baeyer and Bessel, and the former's long experience in triangulation and ordnance survey in Prussia, resulted in his exposé of 1861. Baeyer identified central Europe as the ideal study area, after which he initiated and energetically organised the survey project. Having successfully involved the central European states, Baeyer can be regarded as the founder of international collaboration in geodesy (Torge 2009: 221), and as one of the pioneers of politically contracted international organisations.

By 1862 sixteen states had declared themselves willing to participate in the project. Besides Prussia, Austria and Saxony, Bavaria, Mecklenburg, Hanover, Baden, Saxony-Coburg-Gotha, Italy, Switzerland, Russia for Poland, Belgium, the Netherlands, and Denmark, Sweden and Norway also joined the project.

In 1864 the first general conference took place in Berlin. Despite the delicate political situation caused by the German-Danish war, the meeting was a success. A permanent commission with seven members was elected to take charge of the scientific management of the survey work between the triennial general conferences and to act as the liaison office between the states. The permanent commission met once a year. The 1864 meeting also led to the appointment of a special commission to deal with the standardisation of the metre in order to have a unique scale for all the surveys (Schneider 2012: 86).

The 1866 meeting in Neuenburg (Switzerland) resulted in the formal establishment of the Central Bureau. The office was financed by Prussia and located at the Prussian Geodetic Institute. Its main task was to support the permanent commission in collecting and summarising the annual reports contributed by the participating states for the general report.

When Spain and Portugal joined the project in 1867, five years after the official beginning of the survey, the project was renamed the "European Meridian Arc

Measurement”. This step symbolised the will of the European states to participate in the project and work towards its completion. The main goal, however, was still the question of the true shape of the earth, and this needed further investigation on a world-wide scale. Hence in 1885, one year after Baeyer’s death, the project was renamed again. At the eighth general conference, the first agreement to establish an international association was reached. This agreement mainly dealt with financial questions. The new name, which was decided on, was “International Geodesy”. In 1889 the project had a total of 25 member states which included countries such as Chile, Greece, Japan, Mexico and the US. After back and forth developments during the twentieth century, the current International Association of Geodesy (IAG) can be considered the true successor of Baeyer’s project. The ICA, a sister society of the IAG which was founded in 1959, can also be regarded as result of the 1861 exposé and the ensuing developments in the international field.

Right from the beginning Saxony was much involved in the planned international cooperation. The three commissioners participated in the general meetings, wrote reports about the progress of the work, discussed subject-specific and technical questions with European colleagues, and coordinated their work with neighbouring countries. Bruhns was early on elected secretary of the permanent commission and was responsible for the editing and publication of the annual general report. The construction of the triangulation beacons in Saxony as well as elsewhere can be seen as the contribution of Weisbach and Nagel. Weisbach also developed special benchmarks for the levelling for better retrieval. These benchmarks were later also used by neighbouring countries such as Prussia and Bavaria for their own levelling purposes (Schneider 2012: 88). During this time, students of Weisbach, Bruhns and Nagel also rose to important positions in the survey profession. One of Nagel’s students, Friedrich Robert Helmert (1843–1917), was appointed president of the Prussian Geodetic Institute and head of the Central Bureau after Baeyer’s death in 1886. Under Helmert’s presidency the project acquired even more of an international character. Helmert also made Potsdam a centre for scientific geodesy.

The scientific results of the Saxon survey are considered to be excellent especially with regards to the triangulation as a whole and the base-line measurement. In Prussia, however, there developed serious problems because of double tracked work—the ordnance survey triangulation was continued by the General Staff, whereas the meridian arc measurements were supervised by the Geodetic Institute (Torge 2012: 14).

Acknowledgments The idea to write this paper was instigated by an exhibition on the same theme in the City Archives of Dresden from 10 May until 31 August 2012. I would like to specially thank Andreas Reinhold from Leipzig for supporting the idea and for providing me with references. Additional information was provided by Peter Bien and Wolfram Dolz, both from Dresden. General information on the situation in Saxony was gleaned from a paper presented by Prof. Milos Řezník (TU Chemnitz) at the conference “150 Jahre Gradmessung in Sachsen” held in Dresden on 2 June 2012.

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Jana Moser studied Cartography at the University of Applied Sciences in Dresden from 1994 to 1998. In 2007 she completed her PhD thesis entitled "The History of Mapping of South West Africa/Namibia from the beginning up to independence in 1990". From 2004 until 2010 she acted as Project Manager for the Saxon Academy of Sciences in Dresden where she worked on the "Atlas for History and Applied Geography of Saxony". Since 2011 she is Senior Researcher at the Leibniz Institute for Regional Geography (IfL) in Leipzig where she is responsible for atlas editing and knowledge transfer. Since 2012 she is head of the working group "Visual communication" at the IfL.

Media-Related Aspects of Popularization: The Geographical Serials from the Publishing Houses of Friedrich Justin Bertuch

Andreas Christoph

Abstract Geographical periodicals of *circa* 1800 served to gather material, and to facilitate its rapid evaluation. Travel literature enabled scientists and publishers to report on research travels and at the same time ensured a rapid promulgation of the results of the newest expeditions. Geographical knowledge has always been enriched by the support of both ethnographic illustrations and of cartographic records of remote areas. The aim of the paper is to analyze geographical and cartographical knowledge through texts, images and maps and to discover the strategies of these forms of representation; this will be based on various periodicals issued by the "Landes-Industrie-Comptoir" and the "Geographisches Institut". In an unprecedented form of synthesis an astronomer and a publisher succeeded in issuing the *Allgemeine Geographische Ephemeriden*: this set a new standard in terms of geo-cartographic periodicals in the early nineteenth century. Between 1798 and 1831 a total of 81 volumes of the *Ephemeriden* were published. Contemporaneously in Weimar, another collection was issued that discussed the most recent and most significant travel accounts and news about the progress in geography: the *Bibliothek der neuesten und wichtigsten Reisebeschreibungen und geographischen Nachrichten zur Erweiterung der Erdkunde* (1800–1835). In this way, the world's geographic image received in Germany from 1800 to 1830 was disseminated by the combination of texts, pictures and maps produced at Bertuch's enterprises.

1 Introduction

Maps, atlases, globes and geographical serials were the mainstay of the enterprises of Friedrich Justin Bertuch (1747–1822), the only significant manufacturer of geographic and cartographic products in Germany at the beginning of the nineteenth century. In 1791, Bertuch began to operate under the name of the "Landes-Industrie-Comptoir".

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For strategic positioning in the spatial information market the “Geographisches Institut” was separated off in 1804. Up to the 1830s Bertuch and his staff succeeded in manufacturing and merchandizing a variety of geographic and cartographic materials. The “Geographisches Institut” provided a school series (textbook, school atlas, school globe), a handbook of geography, a geographical journal (*Allgemeine Geographische Ephemeriden*), a collection of the most recent and most significant travel accounts (*Bibliothek der neuesten und wichtigsten Reisebeschreibungen*), a variety of maps, atlases (Espenhorst 2003: 94–176) as well as terrestrial and celestial globes (Christoph 2011: 135–148).

This paper investigates the theoretical and practical background of the most important geographical periodical of *circa* 1800 in the German-speaking area—the *Allgemeine Geographische Ephemeriden*. The presentation of texts, images and maps was the main subject of this periodical. However, travel, as a part of geography, played an important role in the history of earth science. In this context, a collection of the most recent and significant travel accounts, the *Bibliothek der neuesten und wichtigsten Reisebeschreibungen und geographischen Nachrichten zur Erweiterung der Erdkunde*, comes into focus. These two multifaceted geo-cartographic serials are analyzed as interfaces between geography and cartography, as they depicted the landscape of earth sciences literature, from the late eighteenth to the middle of the nineteenth centuries. Different aspects of geography, cartography, astronomy, geology, meteorology, ethnography, and also itineraries and expedition reports were mixed together and annotated with biographical notes and news to ‘appropriate’ the Earth and the sky in all its dimensions.

2 Geographical Serials

2.1 The Geo-Cartographic Periodical

In the second half of the eighteenth century, after the epoch of cosmographies and Enlightenment encyclopaedias, dealing with all kinds of popular and scientific knowledge, a new type of miscellanies became established. A pioneer in the development of geographical periodicals was the German theologian and geographer Anton Friedrich Büsching (1724–1793). He was the editor of the first geographical journal in Germany, the *Magazin für die neue Historie und Geographie* [*Magazine for the New History and Geography*] which was published in Hamburg and Halle from 1767 to 1788. It was accompanied by Büsching’s *Wöchentliche Nachrichten von neuen Landkarten, geographischen, statistischen und historischen Büchern und Sachen* [*Weekly news on new maps, and of geographical, statistical, and historical books and things*] (Berlin 1773–1788). A couple of other geographical journals were unsuccessful in keeping pace with this publishing trend (see Hohmann 1959). After Büsching’s death a long overdue revival of the form and substance of a geographical periodical became necessary.

The local employment and organisation of qualified scientific staff, skilled craftsmen, and advanced machinery—aided by an enlightened government—facilitated a new quality of astronomical/geographical/cartographical periodicals in Weimar, the centre of the Classical Period in Germany. Furthermore, the capital of the (Great) Duchy of Saxe-Weimar-Eisenach was the seat of the “Landes-Industrie-Comptoir” and the “Geographisches Institut”. In cooperation with the owner, Friedrich Justin Bertuch, the astronomer Franz Xaver von Zach (1754–1832) from Gotha was successful in issuing an unprecedented form of synthesized spatial knowledge: namely, the journal *Allgemeine Geographische Ephemeriden* (AGE). The first issue appeared in 1798, followed by 50 volumes until 1816. Volume 51 was a cumulative index which listed geographical coordinates, gave a general register of keywords and people, and supplied a catalogue of maps, plans, portraits and interesting copperplate prints. In 1817 the title changed to *Neue Allgemeine Geographische Ephemeriden* (NAGE, 10 volumes) until 1821, and changed again from 1822 to 1831 to *Neue Allgemeine Geographische und Statistische Ephemeriden* (NAGSE, 20 volumes) (Fig. 1). Between 1798 and 1831 a total of 81 volumes of the *Ephemeriden* were published. The retro-digitized *Ephemeriden* as well as the *Bibliothek der neuesten und wichtigsten Reisebeschreibungen* can be found in the Universal Multimedia Electronic Library (UrMEL) at Thüringer Universitäts- und Landesbibliothek Jena (ThULB). The publishing company was taken over by the “Landes-Industrie-Comptoir”, while the “Geographisches Institut” managed the accompanying related maps.

The plural term ‘ephemerides’ is used to mean an almanac giving the positions of celestial bodies. This indicates the astronomical background of the first editor


Allgemeine Geographiſche EPHEMERIDEN. Verfaſſet von einer Geſellſchaft Gelehrten und herausgegeben von F. von Zach, H. S. G. Obriſtwachtmeiſter und Director der herzoglichen Sternwarte Seeberg bey Gotha. Erſter Band. Weimar, im Verlage des Induſtrie-Comptoirs. 1798.

Neue Allgemeine Geographische EPHEMERIDEN. Verfasset von einer Gesellschaft von Gelehrten, und herausgegeben von Dr. F. J. Bertuch, Großherzogl. Sachsen-Weimar. Legations-Rathe, Ritter des weißen Falken-Ordens, und mehrerer gelehrten Gesellschaften Mitgliede. Erster Band. Weimar, im Verlage des Landes-Industrie-Comptiors. 1817.

Neue Allgemeine Geographische und Statistische EPHEMERIDEN. Verfasset von einer Gesellschaft von Gelehrten, und herausgegeben von dem Geographischen Institute. Eilfter Band. Weimar, im Verlage des Landes-Industrie-Comptoirs. 1822.

Fig. 1 Title-pages of the *Ephemeriden* (1798–1832) (ThULB Jena) of the *Ephemeriden*. The astronomer von Zach was famous for his science policy. His observatory (founded in 1792) on the Seeberg near Gotha was an educational establishment for astronomers. Whereas Zach was keener on publishing about astronomy and geodesy, his organizational abilities were better than his theoretical works (Gore 1889: 784–785). In 1798 Zach organized the first international astronomers' conference in Gotha (Brosche et al. 1998: 63–72). Because Zach wished to bring together scientists of distinction, the preparatory correspondence for this event was enormous. Therefore, the list of participants could be read as a *Who's Who* of contemporary astronomers: Jérôme Lalande (1732–1807) from Paris; the director of the Berlin observatory, Johann Elert Bode (1747–1826); or the professor of astronomy at Göttingen University, Karl Felix Seyffer (1762–1821) (Brosche 2009: 94–107).

For some time past, Zach had been working on the concept for a journal "to undertake the presentation of the latest scientific achievements for astronomers and geographers on a regular basis" (Vargha 2005: 46). Furthermore, Zach and his staff were in contact with Bertuch in Weimar as they revised the most recent maps for the "Landes-Industrie-Comptoir". The personal and scientific interchange between Gotha and Weimar encouraged the publication of the *Ephemeriden*. The first volume appeared in January 1798. Zach's preface ran to more than 50 pages. After a historical sketch he propounded the journal's aspiration regarding the development of geography, astronomy and statistics: "… zur Fortrückung und Verbreitung dieser Wissenschaften möglichst beyzutragen und durch neue und eigene Arbeiten die Gränzen derselben zu erweitern" ["to contribute as much as possible to the progress and propagation of these sciences and to extend their frontiers through new and particular papers"] (AGE 1 1798: 4). The *Ephemeriden* were separated into different categories (treatises, book and map reviews, correspondence and *miscellanea*). Articles were supplemented by tables and figures, portraits, illustrations and hand-coloured maps. A table of contents and an index was a good way to keep track of this agglomerated information. The spectrum of themes included *Geographica*, *Cartographica* and *Ethnographica* from all over the world. Original works, as well as translated articles from foreign journals, were combined with extracts from private correspondence.

The concentration on geo-cartographic topics, by the repression of astronomy within the *Ephemeriden,* was the cause of Zach's retirement as editor in 1799. His successor on the journal's editorial board was the geographer and educationalist Adam Christian Gaspari (1752–1830). Due to Gaspari's appointment to Dorpat University in 1803, he was superseded by Christian Gottlieb Reichard, a lawyer with a great interest in drawing maps. From early 1806 Bertuch was the sole editor and publisher, supported by an undefined "Gesellschaft von Gelehrten" [Society of Learned Gentlemen]. After Bertuch's death in 1822 no editor was explicitly mentioned by name. In late 1830, with no explanation, the NAGE came to a sudden end.

From 1800 to 1806, Zach became the editor of a separate periodical, the *Monatliche Correspondenz zur Beförderung der Erd- und Himmels-Kunde* ["Monthly Correspondence for the promotion of Geography and Astronomy"], published in Gotha. The astronomer Bernhard von Lindenau (1779–1854) took over Zach's task until 1813. While the *Ephemeriden* was a popular scientific periodical, the *Correspondenz* was created for a more sophisticated scientific community. Zach continued to persevere with his publishing career in the 1820s by editing the *Correspondance astronomique, géographique, hydrographique et statistique* (Geneva 1818–1826). As can be seen, Zach was not able to relinquish the complex of cartographic themes.

2.2 Excursion I: Alexander von Humboldt, Johann Wolfgang von Goethe and the Ephemeriden

From 1799 to 1804 Alexander von Humboldt (1769–1859) collected empirical data on his journeys to, and through, Central and South America. After his return to Europe, he committed to paper his descriptions of plants, animals, rocks, as well as peoples. His *oeuvre* culminated in the *Kosmos* [*Cosmos*], an amalgamated work about natural science, published in five volumes in Stuttgart from 1845 to 1862. Between 1805 and 1807 the French publisher Schoell in Paris and Cotta in Tübingen had published Humboldt's *Ideen zu einer Geographie der Pflanzen* ["Ideas towards a geography of plants"]. In addition to a short essay about climate and the distribution of plants, a geo-botanical tableau converts textual knowledge into pictorial knowledge (Bourguet 2002). The publication was dedicated to Johann Wolfgang von Goethe, bearing in mind his *Metamorphose der Pflanzen* ["Metamorphosis of plants"], the first edition was published in Gotha in 1790. Humboldt sent a copy to Goethe but the illustrative chart was missing. Goethe, therefore, designed his own tableau, called "Höhen der alten und neuen Welt bildlich verglichen" ["Heights of the Old and the New World compared pictorially"]. In May 1813 an aquatint print of Goethe's sketch was published in the AGE (Fig. 2).

In a short explanation Goethe amplified the idea and the circumstances of the sketch's origin. Amongst other things, Goethe directed attention to a crocodile that marked mean sea level. Small human figures depicted the heights reached by Horace-Bénédict de Saussure (1740–1799) on the top of Mont Blanc (1787), by Alexander von Humboldt below the peak of the Chimborazo (1803), and by the hot-air-balloon of Joseph Louis Gay Lussac (1778–1850) in 1804. A new version of this comparative tableau appeared in 1821, in volume 10 of the *Bilderbuch für Kinder* ["Children's picture book"]: when the Himalaya, for example, were added.

Lacking original works from Humboldt, Bertuch and his staff provided themselves with reprints from news and articles, either prepared by Humboldt for foreign journals and publishers such as the *Journal de Physique* (see for example AGE 9 1802: 310–329, 389–420 and AGE 31 1810: 241–291), or they used excerpts from Humboldt's own publications like the *Essay politique sur la Nouvelle Espagne* (Paris 1808–1811). Exceptional were narrations of correspondence between Humboldt and Zach and an annotated pictorial supplement,

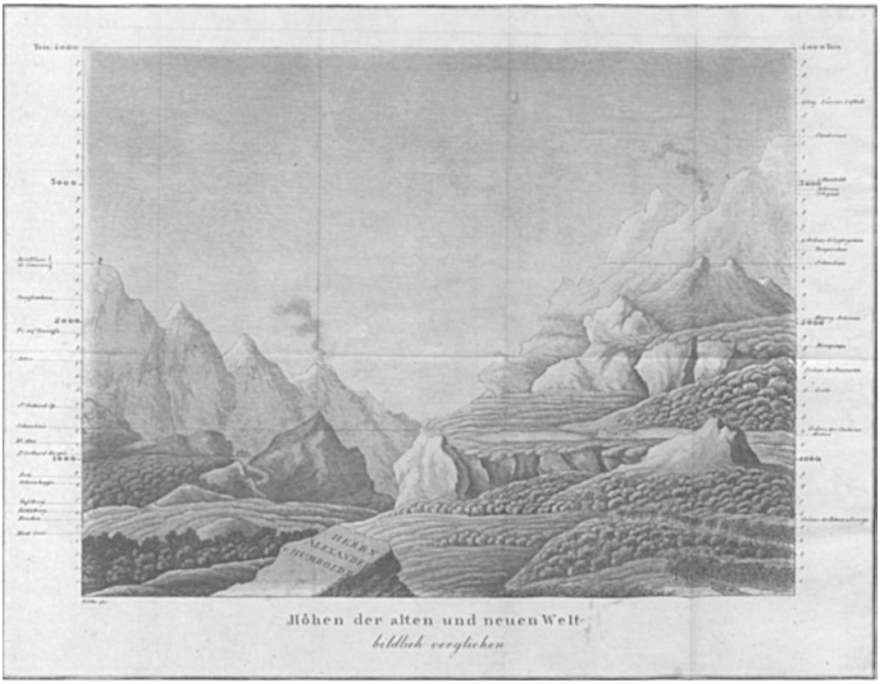

Fig. 2 Goethe's tableau for pictorial comparison of the old and the new worlds' heights (ThULB Jena)

depicting a night on the Orinoco River (Fig. 3). The copperplate print illustrated a typical bivouac in the tropics with vexations like constant rain and panthers, in addition to mosquitoes and crocodiles: "Das Geschrei der Waldtiere ist dann unbeschreiblich und giebt der Scene einen Charakter romantischer Wildheit." (AGE 22 1807: 107–112, here 111: "After that the clamour of the rainforest animals is incredible and conveys a character of romantic savageness."). No subsequent original correspondence from Humboldt was published within the *Ephemeriden*.

3 Geographical Serials: Travel Literature

In Weimar, between 1800 and 1814, a multi-volume collection was issued that discussed the most recent and most significant travel accounts and news about the advancement of geography. Hitherto this collection of travel literature, the *Bibliothek der neuesten und wichtigsten Reisebeschreibungen und geographischen Nachrichten zur Erweiterung der Erdkunde* (BdR) totalling 115 volumes, has awaited a sustained examination. To get an idea of the variety of the BdR, there were three index volumes in 1806 (vol. 1–24), 1808 (vol. 25–36) and in 1814 (vol. 37–50).

Fig. 3 Humboldt's night on the bank of the Orinoco River (ThULB Jena)

The publishers of the BdR were Matthias Christian Sprengel (1746–1803) and his successor, Theophil Friedrich Ehrmann (1762–1811). Sprengel was Professor of History at Halle University and head of the University Library. Before his cooperation with Bertuch, he was the publisher of several geographical journals. Co-authors in these journals had been Sprengel's father-in-law, Jacob Reinhold Forster, and his brother-in-law, Georg Forster. In 1794 he began a collection of translated travel literature. By 1800 he had finished 14 volumes of the *Auswahl der besten ausländischen geographischen und statistischen Nachrichten zur Aufklärung der Länder- und Völkerkunde* ["Selection of the best foreign geographical and statistical notices for the explanation of geography and ethnography"]. Sprengel had an open mind regarding geographical literature and liaised with Bertuch to publish a discerning collection of travel literature. Apart from reviewing the latest foreign publications, the Sprengel and Bertuch publishing duo accomplished the perusal of literary magazines and the compilation of maps. Since the BdR deals only with transcriptions, the content was translated almost without commentary; editorial notes appeared in the form of an introduction. The world's geographic image was imparted by the combination of texts, pictures and maps.

The first volume of the BdR deals with the *Travels in Africa, Egypt, and Syria, from 1792 to 1798* of William George Browne (1768–1813). Browne was the first European to visit Darfur. The first edition of this travelogue was published by Cadell and Davies in London in 1799; the German translation came out in 1800.

Two maps made from Browne's own observations accompanied the original, whereas the Weimar edition was illustrated by a "New map of North-Africa" for the revision of geography and for the illustration of the endeavours made by Mungo Park and Browne a decade before. Sprengel foregoes Browne's detailed itineraries, the meteorological tables as well as country-specific indications of weights and measures. The hasty translation and, moreover, mutual English and Arabian speech intelligibility, was reflected in the misspelling of Browne's name. At about the same time a Leipzig edition of Browne's travels was published. This pressure of competition made Sprengel and Bertuch optimize their publication performance. The next volumes were published in rapid succession; at peak periods there were more than ten volumes *per annum*. To guarantee the frequency of publication Bertuch depends on his commission agents in England and France. In Paris, Friedrich Theophil Winckler (1771–1807) was Bertuch's contact person. In London, the commission agent's job, from 1795 until at least 1819, was taken by Johann Christian Hüttner (1766–1847). Nevertheless, this dependency was complicated by the political situation, especially until 1814 by the Continental System.

From 1815 to 1822 Bertuch became the sole publisher of the publication's sequel. Under the name of *Neue Bibliothek der wichtigsten Reisebeschreibungen zur Erweiterung der Erd- und Völkerkunde* (NBdR) 65 additional volumes were issued until 1835. Furthermore, from 1806 to 1827, the "Geographisches Institut" enlarged the travel literature section by an additional serial. Under the title *Neueste Länder- und Völkerkunde* (NLV) ["Latest Geography and Ethnography"] a 'geographical reading book' in 24 volumes was published. In the early 1820s single volumes were re-issued. Every volume contained copperplate maps and figures. It was the publisher's aspiration to give educational diversion and to meet the demands of inquisitiveness in a popular scientific way. Until his death in 1811 Ehrmann was the main author; he was succeeded by Georg Hassel (1770–1829) and Heinrich Schorch (1777–1822). In the highly competitive book market, complete reprints of single publications were not unusual. Therefore, a plagiarised copy, accompanied by copperplates copied from the original maps of Weimar's NLV, was issued by the Prague publisher, Diesbach. As a representative of German publishers and booksellers at the Congress of Vienna (1815), Bertuch's son, Carl, took a firm stand against plagiarism to prevent this insupportable state of affairs.

3.1 Excursion II: Hüttner's Visualising of China Within the "Geographisches Institut"

During the eighteenth century Enlightenment, Europe was prejudiced by conventional stereotypes of China. Such biased opinions stemmed from the Chinese refusal to allow strangers to travel through the Chinese Empire. In Europe, around 1800, the most famous travels across China were those from 1793 to 1794, carried out by Aeneas Anderson (~1800), Macartney's deputy, George Leonard Staunton (1737–1801), and John Barrow (1764–1848). Staunton was named secretary to the British diplomatic and trade mission to the Chinese imperial court, a mission headed by *Lord* George Macartney (1737–1806). Barrow was comptroller of Macartney's household and Staunton's librarian, Anderson was his valet. The mission attempted to remove the tensions due to the trade monopolies of Chinese business houses. Nevertheless, the embassy returned to London without obtaining any concession from China. Intercultural animosities aside, the mission can be considered as a success since it brought back detailed botanical, zoological and ethnological observations.

In 1797 the official legation report by Staunton appeared in two volumes. In addition to five different German editions, there were also French, Dutch, Italian and Russian translations. The German translation of Staunton's and Barrow's reports was penned by Johann Christian Hüttner who was a travel companion of Staunton and tutor to his son, George Thomas. In the first volume of the AGE (1798), Hüttner had already devoted 20 pages to the latest statistical news of China, as an extract of the Macartney travelogue. In 1804 and 1805, 10 years after the end of the Macartney embassy, John Barrow's descriptions, observations, and comparisons appeared as volumes 14 and 16 in the BdR. Unfortunately, these editions offered only uncritical reflections of the English originals. Even the copperplates were the same, black and white, but reverse-imaged, copies of the original coloured illustrations (Fig. 4). However, Bertuch's company literary newspaper, the *Allgemeine Literatur-Zeitung*, pronounced Hüttner's translation up-to-date and detailed.

Hüttner had experiences in providing fragments of travelogues and anecdotes taken from many London journals; his inquiries on travel literature had an effect on Goethe in his role as director of the Duchy Library in Weimar. Hüttner's impact on the advancement of German literature in the Classical Period was recognised very recently (Guthke 2011: 161–189).

Fig. 4 A Chinese and a Hottentot, illustrations to Hüttner's *Reise nach China* (ThULB Jena)

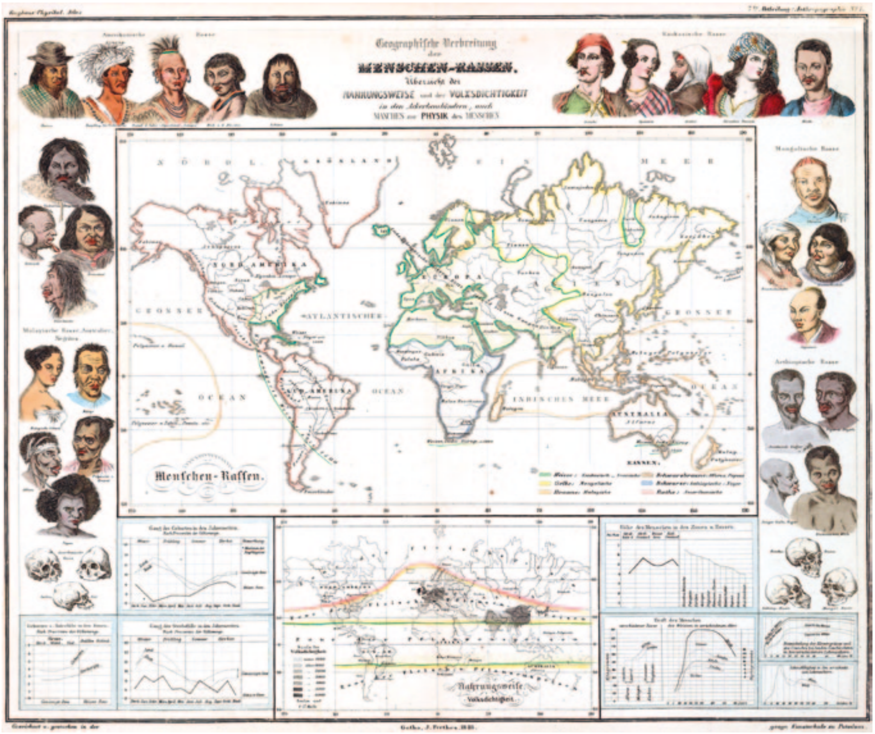

Fig. 5 Heinrich Berghaus (1848) "Anthropographie No. 1" (David Rumsey Collection)

To close a circle, it is important to demonstrate an illustration, published as a supplement to Alexander von Humboldt's *Kosmos*, appearing in the famous *Physikalischer Atlas* of Heinrich Berghaus (1797–1884). The copperplate of "Anthropographie No. 1" from 1848 pictured the geographical spread of the human race with the nature of its foodstuffs, population density, and something about Man's physical characteristics. Astonishingly, with minimal variation, we find Barrow/Hüttner's aforementioned illustrations on the right of the Berghaus map (Fig. 5). This is not surprising, because Berghaus had spent stages of his education in Weimar. The media-related re-utilisation of geographical knowledge by the Bertuch enterprises thus becomes evident and is hereby exemplified.

4 The Later History of the Bertuch Enterprises

Bertuch's working methods and the "Geographisches Institut's" sphere of influence dominated and shaped the geographical knowledge produced in Germany from the early 1790s to the 1830s. Although the company ran smoothly, there were family setbacks. Following the death of Bertuch's son, Carl (1777–1815), the management of the firm lacked a direct successor. Albeit reluctantly, Bertuch's son-in-law, Ludwig Friedrich von Froriep (1779–1847) and, subsequently, his son Robert Froriep (1804–1861), took over the responsibility. In 1815, moreover, a crucial break occurred in the production processes of the "Geographisches Institut". It was decided that a chief cartographer was to administer the map and globe plant. This role was assumed by a former military cartographer, Carl Ferdinand Weiland (1782–1847). Adolf Stieler (1775–1836) was also a potential candidate: after all, he had already worked for 15 years for Bertuch and his distinctive style had contributed to the recognised value of the maps from Weimar. Stieler, however, went to work for Johann Georg Justus Perthes (1749–1816) in Gotha and established the success of his own hand-atlas. Hence there were now two companies in Thuringia that produced maps, atlases and globes.

Over the following years technical innovations concerning manufacturing methods were non-existent in Weimar. As the variety of products became too confusing and too costly to upgrade, the quality of maps, atlases and globes inevitably fluctuated. Thus, the firm admitted that it was unable to react as rapidly as possible to changes, especially those affecting political maps. There was a ray of hope in the 1840s when Heinrich Kiepert (1818–1899) took over the cartographic department. Unfortunately, this rising cartographer stayed only briefly in Weimar as the Berlin publisher Reimer's proposal was too alluring. Neither did the sale of the family business through Robert Froriep satisfactorily resolve the situation, as the firm's management changed frequently over decades. How was one to revise the product programme and to adapt it to contemporary circumstances, not to mention make it economically sustainable and assert oneself in the geo-cartographic information marketplace? It is reasonable to ask why the Weimar publishing company fell out of favour after Bertuch's death in 1822. On the one hand, we can find in the history of the Weimar "Geographisches Institut" all the famous actors who have marked the pre-disciplinary period of German geography and cartography: Heinrich Berghaus, Adolf Stieler or Heinrich Kiepert, all of whom received technical training in Weimar. On the other hand, most of them had considered and used the Bertuch business empire only as a stepping-stone for future opportunities within the firms of Justus Perthes in Gotha or in publishing companies in Leipzig or Berlin. Nevertheless, in the context of the Industrial Revolution, production-related procedures were not sufficiently developed by Bertuch's firm, which, indeed, never went beyond the status of a workshop. Moreover, the multiple changes in ownership contributed to the demise of the name of the "Geographisches Institut" within the scientific world. High expectations always remained but were insufficient to encourage a revaluation of the Weimar trademark. Due to those circumstances the eventual insolvency of the "Geographisches Institut" was foreseeable, and the fate of this traditional knowledge factory was sealed by 1908.

5 Summary

Because of the use of available materials and social structures, Bertuch was able to combine innovation and tradition in order to revitalise German geography and cartography. He exploited the potential of the literature market, while adding to contemporary knowledge about the physical world through critical reviews and the compilation of domestic and foreign publications. The continuation of printing travellers' reports was improved by the addition of maps, which were drafted to a high standard of stylistic elements and convincing symbolism. Prospective clients were attracted by advertising, exceptional offers and preprints of forthcoming projects. Aside from staff migration (with the implicit transfer of their accumulated knowledge), the initial, highly original, concept of *Geographica* and *Cartographica* stagnated in the second half of the nineteenth century. Multidisciplinary periodicals had to make room for topically-oriented professional journals linked to their scientific fields. The holistic concept of the *Ephemeriden* was not accomplished until the mid-1850s by *Petermanns Geographische Mitteilungen*, whereas the period of collections of travel literature peters out. The title-genealogy shows the further development of the periodicals from Gotha: *Geographisches Jahrbuch zur Mittheilung aller wichtigern neuen Erforschungen* (1850–1852); *Mittheilungen aus Justus Perthes' Geographischer Anstalt über wichtige neue Erforschungen auf dem Gesammtgebiete der Geographie* (1855–1878); *Dr. A. Petermann's Mitteilungen aus Justus Perthes' Geographischer Anstalt* (1879–1937); *Petermanns geographische Mitteilungen* (1938–2004); also the *Ergänzungs-Hefte/Ergänzungs-Bände* (1860–1939).

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Andreas Christoph studied Biology, Physical Anthropology and History of Science at the University of Jena. His PhD study within the “Sonderforschungsbereich 482” focuses on the history of cartography around 1800 in context of the “Landes-Industrie-Comptoir” and “Geographisches Institut” from Friedrich Justin Bertuch at Weimar. Since the second quarter of 2012, Andreas Christoph works at the “Ernst-Haeckel-Haus” in Jena.

Exploring Along the Rome Meridian: Roger Boscovich and the First Modern Map of the Papal States

Mirela Slukan Altić

Abstract Roger Boscovich (1711–1787) was one of the most prominent Croatian scientists of the 18th century. In his diverse scientific work, he tried his skills in cartography as well, creating the first map of the Papal States based on modern geodetic surveying principles. In order to determine the figure and size of the earth, in the period 1750–1752, Roger Boscovich, in collaboration with the English Jesuit Christopher Maire, embarked on an expedition to conduct a survey along the meridian between Rome and Rimini. On this occasion, Boscovich collected a series of field data by applying the technique of triangulation, on the basis of which he, in cooperation with Maire, prepared a new map of the Papal States (*Nuova carta geografica dello Stato Ecclesiastico*). An account of the expedition was published in their work *De litteraria expeditione per pontificiam ditionem (On the Scientific Expedition through the Papal States)* (Rome 1755). Maire's and Boscovich's map was published as a separate sheet map within their above work. This work was subsequently translated into French (Paris 1770), and the map of the Papal States appended to the book. Because of its scientific basis, the map became the most influential and most widely reproduced map of the area, giving Boscovich a prominent place as one of the most important cartographers of the Papal States. In this chapter, we report on the new results obtained in an authentic research of the original Boscovich maps of the Papal States as well as of later editions in which Roger Boscovich was named as the author. By comparing the original maps with the subsequent maps modeled on these Boscovich maps, we evaluate Boscovich's role in the development of cartographic science of the second half of the 18th century.

1 Introduction

The problem of determining the figure of the earth was among the central themes of scientific research in the 17th and 18th centuries. Ever since the times of Sir Isaac Newton's theory (1687), suggesting that the effect of gravitational force on

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the figure of the earth would produce an oblate spheroid slightly flattened at the poles (rotational ellipsoid), scientists concluded that the determination of the exact figure of the earth would require very accurate measurements of the length of a degree along a single meridian. To be precise, if the earth is a spheroid flattened at the poles, it would mean that the length of a degree should increase from the equator to the poles. The measurements by Jean Picard (1668–1679), Jacques Cassini and Jacques Philippe Maraldi (1718), however, did not support Newton's theory. To resolve this contradiction, the Paris Academy of Sciences decided to send two expeditions to the equator and North Pole to measure the length of one meridian degree; Charles Marie de La Condamine and Pierre Bouguer went to Peru (1735–1744) and Pierre-Louis Moreau de Maupertuis to Lapland (1736–1737). The results of their measurements finally determined that the length of one meridian degree indeed increases towards the poles, thus confirming Newton's theory on the figure of the earth (Pedly 1993: 59).[1]

Rome did not remain aloof from a certain scientific competition and interest developed in measuring the lengths of meridian degrees and in rectifying the mathematical basis for maps which the new knowledge about the figure of the earth enabled. The scientific research based on these new discoveries was actively supported during the reigns of Pope Clement XII (Corsini) as well as his successor, Pope Benedict XIV. In 1750, the latter commissioned Roger Boscovich to make measurements of the length of one meridian degree along the Rome meridian, thus joining the general trend of implementing new scientific discoveries with the aim of improving the quality of geodetic surveying and cartographic representation of the data obtained from such surveys.

2 Roger Boscovich and the Measurement of the Length of a Degree of Latitude

Roger Boscovich kept a keen eye on the innovations brought by the results of the measurements of the lengths of meridian degrees and confirmation of Newton's theory on the figure of the earth. When analyzing the equilibrium of a rotating fluid mass, Boscovich computed that the value of the flattening of the earth's spheroid amounted to 1/273. He pointed out, however, that the earth was not an ideal rotational ellipsoid and that its irregular shape was due to the irregular mass distribution in its interior. Hence he longed for an opportunity to measure the length of one meridian degree at the same latitude at which it was accurately measured previously, but at a different longitude, in order to later be able to compare the

[1] On this occasion, the expeditions determined that the length of a meridian degree in Lapland was 1.33 km longer than the one in Peru. Subsequently, Jacques Cassini's son, César François Cassini de Thury re-measured the Paris-Perpignan meridian in 1740, undoing earlier errors in the measurements of the length of the meridian degree along the Paris meridian.

obtained results.[2] In order to prove this theory, it was necessary to carry out further precision measurements of one meridian degree in which he wanted to apply his new achievements in the theory of measurement errors as well as his surveying instruments on which improvement he worked (Borčić 1965: 211–236). When a new division of the territories between Portugal and Spain in South America was introduced by the Treaty of Madrid in 1750, Boscovich immediately saw an opportunity for his journey to the equatorial regions. In order to demarcate the lands, it was necessary to make precision maps of the boundary zones, and the Portuguese King asked Franz Retz, the Superior General of the Society of Jesus, to send several mathematicians and geographers who could conduct the surveying and mapping. The challenge was accepted by the three Croatian Jesuits, Roger Boscovich, Franjo Haller and Ignatius Szenmartony. Boscovich submitted his application to participate in the expedition on condition that, after a successful completion of the expedition to Brazil, he would be allowed to measure the lengths of meridian degrees along the equator in order to compare these measurements with the already measured length of a degree of the meridian that passes through Quito. When Cardinal Silvio Valenti Gonzaga, the Holy See's Secretary of State, who shared a strong interest in natural sciences with Pope Benedict XIV, and was familiar with all the latest research on gravitation and the effects of gravity on the figure of the earth (Pedley 1993: 60), learned of Boscovich's interest in the measurement of meridian degrees, he offered Boscovich the opportunity to carry out his measurements in the territory of the Papal States instead of in Brazil, and to compare his results with the measurements of the length of one meridian degree made in southern France. Based on this, Pope Benedict XIV issued an order for an astronomical and geographical journey along the meridian that passed through the tower of St. Peter's Basilica in Rome (Martinović 1997: 175).

Boscovich accepted the task and, in accordance with the Pope's order, decided to measure the length of two meridian degrees along the Roman meridian, between Rome and Rimini. Boscovich chose a companion for this assignment, it was the English Jesuit Christopher Maire (Durham 1697–Ghent 1767).[3] Their expedition was completed between 1 October 1750 and 7 November 1752, with certain additional measurements carried out in September 1753. Maire and Boscovich published a description of the entire expedition, including the results of their measurements, in their book entitled *De litteraria expeditione per pontificiam ditionem*…(Maire and Boscovich 1755a). The data on their expedition were thus made public to the scientific community. Boscovich published his notes on the

[2] This Boscovich's theory was subsequently proven and is still widely accepted. The term geoid for an irregular spheroid shape was coined by Johann Benedict Listing in 1873.

[3] Christopher Maire was a Jesuit educated at the English College at St. Omer. He was admitted to the Society of Jesus in 1715. He moved to the college at Liège to study philosophy. In 1739, he was appointed to the English college in Rome, becoming rector in 1744. Maire was the author of numerous scientific treatises in the field of astronomy. From a very young age, he showed a strong interest in cartography. At the age of fourteen, he compiled a large scale map of the County Palatine of Durham (Pedley 1993: 61).


DE
LITTERARIA EXPEDITIONE
PER
PONTIFICIAM DITIONEM
AD DIMETIENDOS DUOS MERIDIANI GRADUS
ET CORRIGENDAM MAPPAM GEOGRAPHICAM
JUSSU, ET AUSPICIIS
BENEDICTI XIV.
PONT. MAX.
SUSCEPTA A PATRIBUS SOCIET. JESU
CHRISTOPHORO MAIRE
ET
ROGERIO JOSEPHO BOSCOVICH.

ROMÆ MDCCLV.
IN TYPOGRAPHIO PALLADIS
EXCUDEBANT NICOLAUS, ET MARCUS PALEARINI
PRÆSIDUM PERMISSU.

VOYAGE
ASTRONOMIQUE ET GEOGRAPHIQUE,
DANS L'ÉTAT DE L'EGLISE,
ENTREPRIS PAR L'ORDRE ET SOUS LES AUSPICES
DU PAPE BENOIT XIV,
Pour mesurer deux dégrés du méridien, & corriger la Carte de l'Etat ecclésiastique,
Par les PP. MAIRE & BOSCOVICH de la Compagnie de Jesus,
TRADUIT DU LATIN,
Augmenté de Notes & d'extraits de nouvelles mesures de dégrés faites en Italie, en Allemagne, en Hongrie & en Amérique.
Avec une nouvelle Carte des Etats du Pape levée géométriquement.

A PARIS,
Chez N. M. Tilliard, Libraire, Quai des Augustins, à S. Benoît.
M. DCC. LXX.
AVEC APPROBATION, ET PRIVILEGE DU ROI.

Fig. 1 Title pages of Roman and French edition of Maire's and Boscovich's books which contains a description of their expedition through the Papal States (National Library Zagreb)

expedition three more times: in 1757 in a summary report for the journal of the Academy of Bologna, in 1760 as a supplement to the poem by Benedikt Stay, and finally in 1770, in the French translation of the work *De litteraria* that was published in Paris under the title *Voyage astronomique et géographique, dans l'État de l'Eglise* (Fig. 1).

When measuring the meridian degree, Boscovich used a method that had already been used for the geodetic measurements of the French academicians: the polygon triangulation. The end points of the measurement along the meridian were tied to a chain of triangles whose vertices were set up on hilltops, so that their adjacent vertices remained clearly visible. The end points of the meridian arc were established at the top of the dome of the Basilica of St. Peter and the mouth of the River Ausa near Rimini, respectively, while triangulation stations were set up at the Collegio Romano in Rome and the Palazzo Garampi in Rimini (Martinović 1992: 275–289).

They selected eight highly visible elevations between Rome and Rimini, which served as trigonometric points for their observations and measurements, and laid out a set of triangles. In addition to the top of the dome of the Basilica of St. Peter in the Vatican, the hilltops used as trigonometric points included (going from Rome to Rimini): Monte Genarro, Monte Soriano, Monte Fionchi, Monte

Pennino, Monte Tezio, Monte Catria, Monte Carpegna, and Monte Luro (Maire and Boscovich 1755a: 132). At a length of about 240 km, Boscovich and Maire measured a trigonometric network consisting of 9 triangles. As a starting point for their triangulation, they astronomically measured two base lines of roughly the same length (approximately 12 km), one in Rome and the other in Rimini. The Roman base line was established along the Via Appia Antica, from the Tomb of Caecilia Metelli to the toponym on the property of the Colonna family that was known as Frattocchie (Maire and Boscovich 1755a: 64), while the Rimini base line commenced at the mouth of the Ausa River and extended southeastwards to the coastline of the Adriatic (Maire and Boscovich 1755a: 83). For their measurements, Maire and Boscovich used the French unit *toise* (about 1,949 m) in order to be able to more easily compare their results with the results of the measurements of the length of the meridian degree in France. It is interesting to note that in their meridian degree measurements, they could, amongst other things, rely on Cardinal Silvio Valenti Gonzaga for the use of his personal observatory built on top of the Aurelian city walls.

They used all the trigonometric points to accurately measure the positions (latitude and longitude), the angles which the points make with their adjacent points, and the distances from the adjacent points. In addition, by using the points of the main mesh of triangles, they also determined the positions (longitude and latitude) of a number of other points. Eventually, they were able to very accurately measure the distance between Rome and Rimini and the difference in their latitudes, respectively, which enabled them to calculate the value of the length of one meridian degree. The French translation of the report on the measurement of the meridian arc between Rome and Rimini was supplemented with a *Note* in which Roger Boscovich presented the error rectification method, his main achievement in statistics, and compared his data with the data obtained from other geodetic surveys conducted in the period 1755–1770 (Maire and Boscovich 1770a: 501–512) (Fig. 2).

As the final result of their measurements, Maire and Boscovich calculated the mean value of the length of the arc of the meridian degree to be 56,979 toises (Maire and Boscovich 1755a: 159) or 111,054 m, which implied that the meridional circumference of the earth amounted to 39,979.44 km. This had further confirmed the theory that the earth was a rotational ellipsoid (the length of the meridian degree measured in Paris at that time was 57,048 toises, thus Newton's theory was once again confirmed).[4]

For the purpose of obtaining a better insight into the extent of Maire and Boscovich's field enterprise, it should be noted that in two years, Boscovich and Maire travelled more than 2,000 km, regularly climbing mountains that were sometimes more than 1,000 m high. At the time of the expedition, Maire was

[4] The accuracy of Boscovich's data on the circumference of the earth was confirmed by Hayford's measurements in 1906, which determined the meridional circumference of the earth to be 40,009.114 km. The currently valid International Standard on the earth's dimensions (WGS 84) determines that the polar circumference of the earth measures 40,007.863 km.

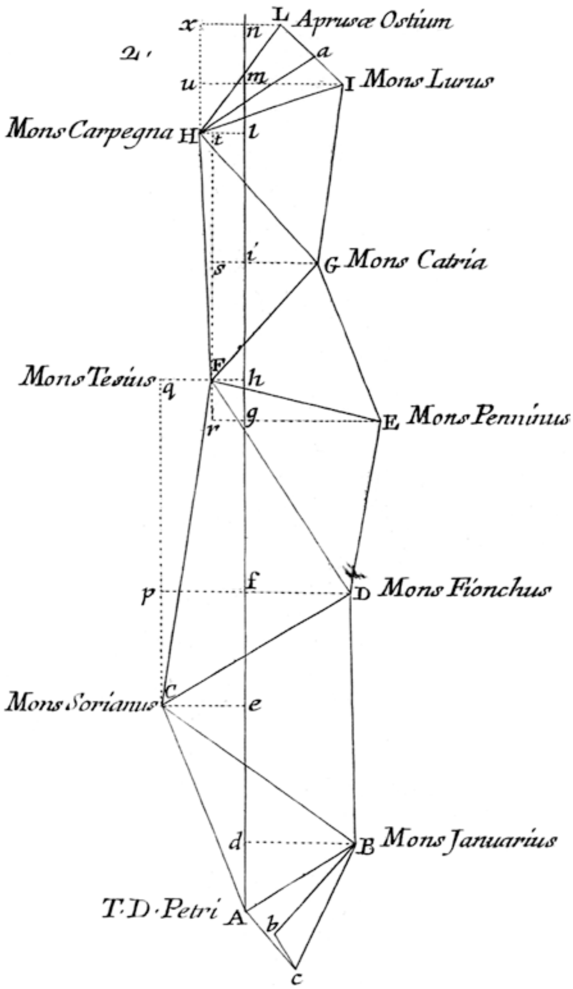

Fig. 2 Scheme of triangulation network established by Maire and Boscovich published in their book "De litteraria" (National Library Zagreb)

53 years old and Boscovich 39. During the entire expedition, they only had four assistants to help carry the instruments. (The quadrant itself, which was used in angular measurements and made according to Boscovich's specifications, weighed about 135 kg!). Moreover, Maire was carrying another smaller quadrant, a sextant, and a measuring table (plane table) (Maire and Boscovich 1755a: 213). Their entire equipment was carried on horseback, uphill, through swamps, and frequent fogs and storms, which particularly hindered their efforts (at Monte Tezio near Perugia, a powerful storm claimed their notes; luckily, they were able to copy some parts before the unfortunate event). Besides, the tense political situation on the borders of certain provinces was causing additional problems (on the border with Tuscany their journey was interrupted by a border dispute). However, none of this distracted the two decisive and persistent scientists from

completing their assignment of measuring the length of one meridian degree and from contributing to the scientific debate about the figure of the Earth.

3 The Map of the Papal States

Maire and Boscovich used the extensive data they compiled in their measurements conducted in the period 1750–1753 for yet another purpose: the compilation of a map of the Papal States or, more specifically, for the correction of the existing maps of the area. Accordingly, Maire and Boscovich published their map of the Papal States on a separate folio as a supplement to their book that was issued in 1755 and dedicated to Pope Benedict XIV. According to the inscription, the map was drawn by Christopher Maire himself, on the basis of measurements carried out jointly by Maire and Boscovich and the methodology developed by Boscovich. The map was printed as a copper engraving on three sheets, and comprised extensive explanatory notes at the upper right corner of the first map sheet (Maire and Boscovich 1755b).

The map's content was defined by its intended use: to display the territorial extent and topography of the Papal States, and to correct, within the bounds of the possible, the mistakes of older maps. The latter was reflected in the title of a chapter of their book *De litteraria expeditione*, in which they described the emergence of their map: *Representations of What Was Derived in Order to Correct the Map of the Papal States (Enarratio eorum, quae ad corrigendam tabulam geographicam Ditionis Pontificiae peracta sunt*) (Maire and Boscovich 1755a: 167–190). Thus, it was clear from the very beginning that their survey was neither entirely new nor an effort to compile a detailed topographic map, but rather an attempt to correct, as much as the time permits, the existing geographical errors on the basis of the measurements primarily conducted for the purpose of measurement of the length of one meridian degree, and to compile the most accurate map possible based on the results obtained. Maire and Boscovich stated on several occasions that the existing maps had not been of much use to them (they used only the maps compiled on the basis of field surveys). In addition to the existing maps of the Papal States, older maps of individual duchies helped them to a certain extent as well. According to the authors, however, even these were full of errors (Maire and Boscovich 1755a: 177–178). Due to a lack of time and poor weather conditions hindering their operations, Maire and Boscovich often approached the local population for assistance, obtaining information about specific localities that was often contradictory. Maire and Boscovich measured the most they could possibly have under the circumstances, knowing that an entirely accurate map required a topographical survey for which they neither had the time nor the financial resources. Thus they compiled a map that was based partly on older data and partly on new, corrected data obtained from their surveying.

The map represents the territorial extent of the Papal States of the time with the division into individual duchies or autonomous units within that territory (jurisdiction boundaries were indicated by dotted lines). The first sheet comprises the following areas: the Legazione di Ferrara, Legazione di Bologna, Legazione di Romagna, and Legazione di Urbino, as well as the Republic of San Marino. The second sheet represents the central part of the Papal States with the jurisdictions of the Governo di Città di Castello, Territorio di Perugia, Territorio di Orvieto, Umbria, Marco di Fermo, Stato di Camerino, and Marca d'Ancona. Along the left edge of the second sheet, within the decorative cartouche, the authors created a list of major towns with their Latin and Italian names. The third sheet of the map comprises the areas of the Patrimony of St. Peter, Campagna di Roma and Sabina. The title cartouche of the map is in the lower left corner of the third sheet. A grid of parallels and meridians is drawn along the outer edges of all sheets (according to the Ferro meridian) (Fig. 3).

The map as well as the book were printed in the printing press Calcografia della Reverenda Camera Apostolica in Pie di Marmo in Rome. The map has no indication of the engraver, but the archive of the above mentioned printing press keeps a record stating that a certain Felice Polanzani was paid for etching work on the Maire and Boscovich's map in the spring of 1755, and the salary for making the cartouche was received by Gaetano de Rossi. It is not known how many map prints were made but 600 copies of the book were printed according to the data on the costs kept in the archive of the printing press (Pedly 1993: 68, 70). According to Amato Pietro Frutaz (1972: I, 90), the copper plates of the Maire and Boscovich's map still exist at the printing press (known today as the Calcografia Nazionale).

The map scale was indicated in the second and third sheets and was expressed in several different units of measure in accordance with the usual custom of the time. In addition to the Italian (*miglia romana*) and English miles (*miglia d' Inghilterra*) and French leagues (*leghe di Francia*), the graphic scale was expressed in several

Fig. 3 Detail of the map of the Papal States (1755) made by Maire and Boscovich (Bibliotheque National de France)

regional varieties of the Italian mile (*miglia d'Ancona, miglia di Bologna, miglia di Fermo, miglia di Ferrara, miglia di Perugia, miglia di Ravenna, miglia di Firenze*). When converted to the metric system, the scale of the above mentioned the map was 1:375,000.

The relief was presented very schematically. The relief forms of only the most dominant elevations were represented by hill shading. Usually, the names of elevations (oronyms) were indicated as well. The authors displayed, to a feasible extent, all the watercourses; in several places of their book, however, they mention that they had checked the routes of the watercourses as far as this was possible, but that they had to rely on older maps as well. Their attempt to mark the wetlands and periodical lakes which significantly change their sizes during the season is particularly interesting, and one can see that they paid special attention to marking such areas (e.g., the wetland area around Bologna).

In accordance with the intended use of their map, which was to correct the errors of older cartographic attempts, the authors paid specific attention to the exact indication of the position of settlements. Because of their poorer mathematical basis, this was precisely the weak point of the existing cartographic representations. Since Maire and Boscovich were aware of this problem, in addition to trigonometric points, they promptly measured the positions (longitude and latitude) of as many settlements they were passing through during their expedition as they could. In this way, Maire and Boscovich calculated the coordinates of 84 localities in total. Based on these measurements, they were able to more accurately indicate the positions of the settlements on their map. Older data were used only for the settlements they were unable to measure in person (the authors drew a small crescent-shaped mark, a lunette, next to every settlement that was indicated on the basis of older data).

According to the key of the map, appropriate symbols were used to categorize localities as seats of an archbishopric, seats of a bishopric, seats of an estate (county), towns with a post office, as well as monasteries and towers. The authors thus marked almost all the settlements, also defining their functions and hierarchical relationships between the individual settlements of the wider region. Apart from the settlements, postal roads were marked as well, mainly according to the data from the existing maps which served as their base maps. In this way, building upon a rather generalized natural-geographical basis that was based on older cartographic representations, they managed to display in reasonable detail all the settlements and jurisdictions, which comprised the territory of the Papal States. Despite its shortcomings, up until then, it was the most accurate map of the Papal States, and as such used as base map for subsequent maps of the same area until as late as the early 19th century.

The map was republished in the 1770 French edition of their book (Maire and Boscovich 1770b). The map attached to the latter edition was printed in a much smaller size than the 1755 edition (it was reduced by approximately three times). Accordingly, the scale was considerably reduced to equal approximately 1: 1,110,000 in the metric system. Because of the smaller scale, the map's geographical content was also reduced to a certain extent. (Some smaller settlements were

Fig. 4 Comparison of the first (*left*) and the second (*right*) edition of the map (all toponyms omitted in the second edition are marked *red* by author)

omitted, for example, the localities with towers and those with uncertain location information) (Fig. 4).

Just like the 1755 map, this map was also a copper plate engraved print. Apart from the scale, this map differs from its older base map in the artistic workmanship, which in the 1770 map was considerably simplified. The decorative title cartouche was left out completely, and the title of the map and author's remarks were inscribed together in a simple box placed in the upper right corner of the map. The map's graphic scale, now expressed only in the Roman miles, French leagues and the common miles, is also devoid of any artistic embellishments.

4 Maire, Boscovich, or Maire-Boscovich: The Issue of Authorship

One of the central issues regarding the above map of the Papal States is certainly the issue of its authorship. From the title in the cartouche, *delineata dal P. Cristoforo Maire*, it is clear that the map was drawn by Christopher Maire. Maire himself, however, states in the same cartouche that the map he drew was compiled on the basis of data obtained in the survey that was jointly conducted by himself and Boscovich:…*osservazioni sue e del P. Ruggiero Gius. Boscovich.* It should be noted that the method of their survey and the calculations of the positions that were applied in this process comprised a method devised by Boscovich known as the error rectification method, but that, according to Boscovich's own words, the idea to use the data collected in the measurements of the length of the meridian degree in the production of a map of the Papal States came from Maire (Maire and Boscovich 1755a: 51–52).

With the above said in mind, when it comes to the authorship question, Maire and Boscovich are to be listed as co-authors, Maire's name, however, should be stated first. (In the catalog of the National Library of France (BNF) the two authors are listed in this way precisely). The aspect in favor of the idea of treating maps as co-authored works, is the fact that, today, we do not necessarily assume that the author of the map is the person who has physically drawn it, but the one who has collected the data and thus determined its content. It is also interesting that, despite the fact that both names are stated in the cartouche of the map (Maire's name first), their contemporaries as well as cartographers of the late 18th and early 19th centuries attribute the map solely to Boscovich, wrongfully concealing Maire's contribution.[5] Such subsequent attribution of the authorship only to Boscovich is more the result of Boscovich's fame and scientific authority among the scientists of the time than the actual cartographic merit in the creation of the said map, in which Christopher Maire holds at least as important a place as Boscovich himself.

5 Possible Cartographic Sources

As previously said, it is quite evident from the notes left to us by Maire and Boscovich that for the compilation of their map they also utilized older cartographic sources, but failed to mention which in particular. Not to state the copyrighted works they had used, might have been regarded as a form of diplomatic etiquette. They in fact refer to the existing maps mainly to point out the geographical errors the latter contain. In this regard, stating a cartographer's name might have been considered personal criticism of someone's work. In this context, the only map which is explicitly mentioned, is the map of Ferrara, Bologna and Ravenna, which the Jesuit Ippolito Silveri dedicated to Benedikt XIV, and of which Boscovich says it was of great use to them. Today, there is unfortunately no trace of this map.

Moreover, it is also evident from their notes that they used multiple cartographic bases, which can be divided in two different types: the existing maps of the Papal States and the maps of certain Italian jurisdictions (duchies). It should be noted that from 1620 onward, the number of the maps of the Papal States and certain Italian jurisdictions was rather significant. It was the year of the posthumous publication of the renowned *Atlante geografico d'Italia*, which was compiled by

[5] It is interesting to note that *De litteraria* mentions three other maps by Maire: the Campagna Romana, the Isola di Tevere (joined to Boscovich's dissertation on the flooding of this river), and the Legazione di Urbino.

the Italian cartographer Giovanni Antonio Magini. His atlas included not only the map of the Papal States (*Stato della Chiesa*), but also the detailed maps of almost all the Italian provinces. This atlas or, more precisely, the maps comprised in this atlas would serve as the data source for cartographers of the 17th and early 18th centuries. Accordingly, the maps of the Papal States and of certain Italian provinces would be published by many European cartographers. That being said, the number of possible cartographic bases was considerable. Having in mind, however, that Maire and Boscovich certainly had access to the best and most recent maps of the time, the choice narrowed considerably.

Among the best maps of Italy published on the eve of Maire and Boscovich's expedition, one should particularly emphasize the maps published in the *Mercurio Geografico*, the best Italian atlas of the era, which was printed in Rome by the renowned cartographer and publisher Giovanni Giacomo De' Rossi.[6] This atlas, first published in 1684, underwent several editions, but has now become very rare.[7] The editor of the atlas responsible for the selection of the maps was the renowned cartographer Giacomo Cantelli da Vignola whose maps were also published in the aforementioned atlas.

In his atlas, De' Rossi included a map of the Papal States that was compiled in 1669 on the basis of a survey conducted by Michele Antonio Baudrand (1633–1700), a French monk and royal cartographer (De' Rossi and Baudrand 1669). It was at that time one of the most widely copied bases for the cartographic representation of the Papal States, and as such underwent many redactions in numerous European atlases. The above-mentioned map from De' Rossi's atlas was also used for the two maps of the Papal States published on the eve of Maire and Boscovich's expedition: the Nolin's (1742) map and the Isaac Tirion's map of the Papal States published in the *Atlante novissimo, che contiene tutte le parti del mondo* 1740 by Girolamo Albrizzi (Tirion 1740). Based on the foregoing, we may conclude that, even in the mid-18th century, the De' Rossi's map of the Papal States was the underlying map base as regards the representation of the Papal States, which base Maire and Boscovich might have used as reference as well. It should be noted that all of the above-mentioned maps of the Papal States were made at a much smaller scale than the ones produced by Maire and Boscovich. Thus, it is clear why the two authors made use of a number of more detailed maps in their work, such as the maps of certain Italian provinces in particular, using them to supplement their own map of the Papal States. The information on the best contemporary regional maps was also provided to them by De' Rossi's atlas. Apart

[6] Giovanni Giacomo De' Rossi (1627–1691) was one of the most important Roman printers and publishers of his time. He inherited the printing press founded by his father Giuseppe (1570–1639). De' Rossi specialized in the publication of maps and atlases. His major work, the atlas *Mercurio Geografico*, was published in several editions from 1684 to 1714.

[7] It was printed in Rome by Giovanni Giacomo De' Rossi and by his successor, Domenico De' Rossi. Domenico De' Rossi (1659–1730) was an Italian engraver and printer. He inherited the printing press from his father Giovanni Giacomo in 1709.

Fig. 5 Baudrand's map of the Papal State (1669) published in De' Rossi's atlas—probably used as the main cartographic source of the Maire-Boscovich's map (Barry Lawrence Ruderman Antique Maps)

from the map of the Papal States, it namely contained the maps of Italian provinces (duchies) as well. At (Fig. 5).

At the same time, De' Rossi was also regularly expanding new editions of his atlas with new maps, particularly the maps of Italian regions. In the late 18th and early 19th centuries, De' Rossi published a number of maps of Italian provinces, which were based on the then contemporary field measurements, not only within the atlas itself, but also as separate sheets. These maps might have been available to Maire and Boscovich as some of the very best cartographic representations of certain Italian regions. The area around Rome (*Campagna di Roma*) was presented in a detailed map produced in the atlas of Widman (1684). The Province of Lazio and Patrimony of St. Peter (*terrestre del Patrimonio di San Pietro*), respectively, were represented in a detailed two-sheet map produced by Giacomo Filippo Ameti (the first edition was published in 1693, the second in 1696). Three years later, a map of the Patrimony of St. Peter was produced by Ameti (1696). The map of the areas of the province of Urbino and Cittá di Castello was produced at a scale of ca. 1:190,000 by Filippo Titi (1697). The same author produced a detailed map of the province of Romagna (Titi 1699). The subsequent Domenico De' Rossi's editions included some new detailed maps of the provinces, and in 1709, he published a map of the province of Ferrara at a scale of ca. 1:215,000 (De' Rossi 1709). In 1710, he printed a map of the province of Bologna at a scale of ca. 1:180,000 (De' Rossi 1710), based on the data obtained from Giovanni Antonio Magini. A detailed representation of the provinces of Ancona and Ferrara was compiled at a scale of ca. 1:190,000 by Amanzio Moroncelli (1711). A year later, Moroncelli also produced a detailed map of the province of Umbria at a scale of ca. 1:205,000 (Moroncelli 1712). Finally, the most recent map of the province of Sabina by the Calcografia Camerale was released in 1743 (Campiglia 1743).

All these maps must have been well known and available to Maire and Boscovich, and they were able to use them to amend their own map of the Papal States. Also, not less important is the fact that subsequent editions of De' Rossi's maps were printed by the Calcografia Camerale where the Maire-Boscovich's maps were printed as well, which only serves to confirm that the above mentioned maps were readily available to them.

6 Echoes of Boscovich's Cartographic Work on Maps of His Successors

Even before the work on it was completed, due to Boscovich's scientific reputation and the French translation of the work *De litteraria expeditione*, the Maire-Boscovich's map of the Papal States was quickly noted by other cartographers as well. Even during the expedition, Joseph-Nicolas Delisle, the renowned French astronomer and cartographer, for instance, corresponded with Maire to inquire about the results of the surveying and appearance of the future map (Pedley 1993: 68).

The map found an echo in the cartographic community almost immediately after its publication in 1755. Already in 1757, in the introduction to his *Atlas universel*, Robert de Vaugondy, the French cartographer, mentions the new map of the Papal States as one of the most awaited maps of the decade. (Interestingly enough, on his map of the Papal States, de Vaugondy did not mention the map base that was more than obviously put to use in the map's compilation).

Even in Boscovich's lifetime, in Italy, the Maire-Boscovich's map of the Papal States underwent several editions in various redactions, all of them unambiguously referring to Boscovich. Thus, the map of the Papal States and the Grand Duchy of Tuscany from 1769 included the information that the said map had been compiled based on the surveys by the two above-mentioned scientists and by Ferdinando Morozzi (Martinović 1992: 280). This testifies to the great importance the Maire-Boscovich's map, shortly after it was produced, had for the Italian cartographers and the development of cartographic representations of the Papal States in general. The major impact of this map was confirmed in the fact that Paolo Santini, one of the more renowned Venetian cartographers and publishers, released his own redaction of the Maire-Boscovich's map on three sheets in 1776, expressly stating the Boscovich's survey in each sheet as the main source of data (Santini 1776). Since Santini's map is almost identical with the Maire-Boscovich's 1755 map, it can be considered a reprint of the original that was translated into Italian. It was made to the same scale (approximately 1:375,000). On both maps, the key was almost identical (for example, instead of circles, Santini introduced different labeling for villages, and omitted crescent marks for localities whose positions were not verified by Maire and Boscovich). The content of the Santini's map is also quite congruent with the one produced by Maire-Boscovich; the only difference refers to the modification of the cartouche and colored representations of the boundaries between individual jurisdictions, which Santini introduced to increase the visibility of his map. In place of the extensive map legend in the Maire-Boscovich's map, Santini inserted Jean Baptiste d'Anville's historical map of the territories that would later comprise the Papal States, deftly solving the problem of the empty space that would remain in the top right corner of the upper sheet.

Interesting information about the Maire-Boscovich's map is revealed in the book printed in Venice in 1795 by Antonio Zatta. In his work entitled *Geografia storico politica. Stato della Chiesa* he states that, until then, the territories of the Papal States were displayed on several different maps, for example, in the 1748 map produced by Tobias Maier and J. B. Homann's successors, respectively. He further states that the map compiled by Maire and Boscovich in 1755 on the basis of own measurements particularly excels in its importance and scientific foundation. He also says that this map can be purchased in Rome for 45 baiocchi (equivalent to five centesimi), which is particularly important because it refers to the fact that the latter map was available to all interested buyers on the market, and that its distribution was not tied together with the book *De litteraria*.

The Maire-Boscovich's map was an inspiration and data source for the Italian cartographers of the late 18th and early 19th centuries. In fact, in addition to the representation of the Papal States, the latter map was also used as data source in the compilation of maps of individual duchies, which at the time of the Maire-Boscovich's map comprised the Papal States. This applies particularly to Marche and the Duchy of Urbino, where Maire and Boscovich spent much time measuring the Rimini's basis for their triangulation, trying to determine as accurately as possible the position of the Papal States along the western Adriatic coast. One of the first cartographers who used the Maire-Boscovich's map as a base for the compilation of his maps of Marche was precisely Antonio Zatta. In his 1779 *Atlante novissimo,* he also included a map of the regions of Urbino and Castello that was compiled on the basis of, as he states in the sub-title of his atlas, *"sulle osservazioni e scoperte fatte dai più celebri e più recenti geografi"(on observations and discoveries made by the most famous and most recent geographers*). While not explicitly mentioned anywhere on the map, it was entirely based on Maire-Boscovich's map base (Zatta 1779).

Since the maps of Italian provinces were also widely copied by other European cartographers, in the late 18th century, echoes of the work of Maire and Boscovich can be found in the cartography of other European countries as well. An example of this is the map of the Duchy of Urbino entitled *Das Herzoghtum Urbino mit der Grafschaft Città Di Castello* that was published in 1790 by Franz Johann Joseph von Reilly. The reminiscences of the geodetic survey conducted by Maire and Boscovich are occasionally found in the early 19th century as well. Specifically, their map of the Papal States was used as a map base for the representations of the Metauro region (Zani 1813).

The strong influence of the Maire-Boscovich's map base is visible on the maps of the Italian regions published in the atlas of the renowned cartographer Giovanni Maria Cassini in 1791. His representations of Urbino, Marche, Umbria, Cambrina, Perugia, Orvieto, and Castello largely rely on Maire-Boscovich's data (Cassini 1791a). The same can be said of his map of Rome, the Patrimony of St. Peter and the province of Sabina, in which Maire's and Boscovich's influence is more than evident (Cassini 1791b). It is not surprising: Cassini's maps were published in Rome by the Calcografia Camerale, the same printing press that published the 1755 Maire-Boscovich's map.

On the basis of the foregoing, we can conclude that the achievements of the geodetic surveying of the Papal States and of Maire-Boscovich's cartographic works compiled on the basis of such surveying had a decisive influence not only on the quality of cartographic representation of the central parts of Italy, but on the European cartography in general. Maire and Boscovich's joint expedition to measure the length of the meridian degree and to use the survey results in order to

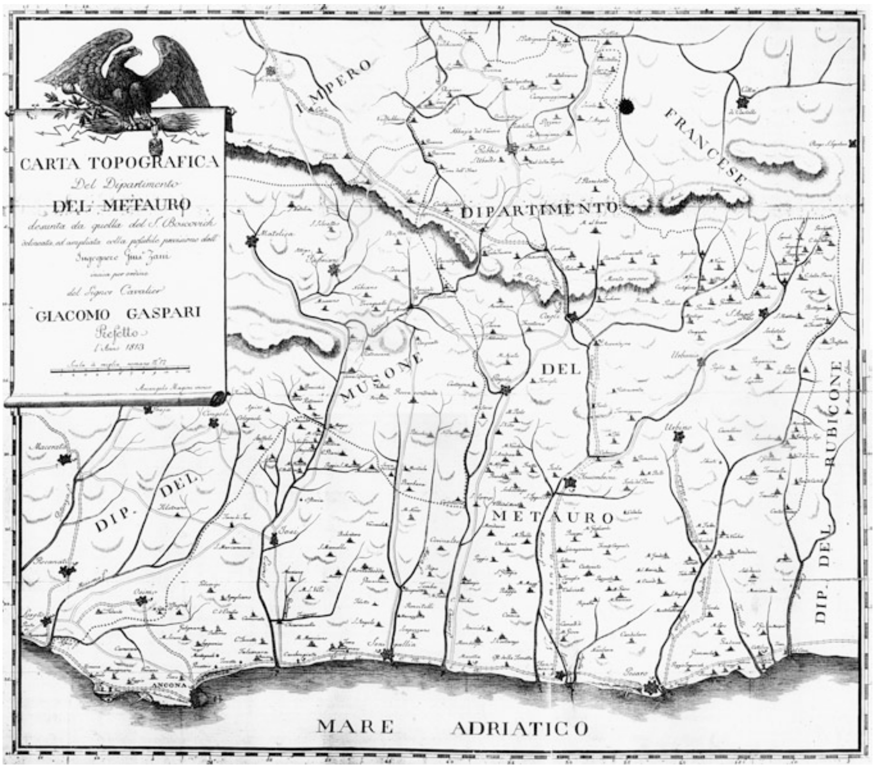

Fig. 6 Map of Metauro region (1813) based on Maire-Boscovich's map (Croatian State Archives)

correct the cartographic representation of the Papal States directly affected subsequent measurements that would contribute to a better understanding of the exact shape and size of the earth (Fig. 6).

Thus, at the initiative of Boscovich, Maria Theresa of Austria encouraged similar measurements in the Habsburg Monarchy (in 1768, Liesganig conducted the measurements of the Vienna meridian from Bratislava to Varaždin), the Royal Society of London supported the surveying of the meridian degree conducted in North America in 1764 by Charles Mason and Jeremiah Dixon, while in Piedmont, King Charles Emmanuel III enabled the measurement of the length of one meridian degree from Turin to Montalto accomplished by Father Beccaria in 1768 (Maire and Boscovich 1770a: 36–37, 479–480).

At the same time, the Maire-Boscovich's map was transmitted for decades, either literally (as reprints in new redactions) or indirectly (by transmitting only a certain specific content, or by referring to the authority of Boscovich's name), thus testifying to the high level of their scientific achievement and great reputation among their cartographic contemporaries. The Maire-Boscovich's map base was not only copied by Italian, but also by German, Austrian, French and Dutch publishers. In that way, their work was included in all the major cartographies of the era. There was a generally accepted consensus among all the cartographers of the time that their map of the Papal States was a milestone event of 18th century cartography in Italy. This had been the foundation of the recognition and reputation of the two tireless researchers so many years ago that continues to this day.

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The Mineral Maps of L. F. Marsigli and the Mystery of a Mine Map

Antal András Deák

Abstract This paper deals with the results of my research on Luigi Ferdinando Marsigli (1659–1730) as published in my books "Discovery of the Danube" (Deák 2004) and "Maps from under the Shadow of the Crescent Moon" (Deák 2006). In the first I elaborated on the history of L.F. Marsigli's Danube Monograph (Marsigli 1726) and in the second on the maps that became famous under the name of Marsigli. The more than 250 manuscript maps described and published as illustrations on the enclosed CD can be found in the Marsigli estate that is preserved at the Biblioteca Universitaria Library in Bologna. They can be divided into two major categories according to their subjects: a smaller portion of them were made for Marsigli for his six-volume work entitled the *Danubius Pannonico-Mysicus*, but the majority were manuscript maps, first published in our book, which Marsigli had prepared during the course of the demarcation of borders between 1699 and 1701 following the Treaty of Karlovitz. The mine maps and site plans that we will take a closer look at in the following were, for the most part, published in 1726 in the 3rd volume of the aforementioned Danube Monograph. In this paper I will briefly outline the background history of the origin of the maps, and then take a closer look at their special qualities and points of interest

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1 The Danube Monograph

1.1 Marsigli, the Conceptual Author of the Mineral Maps

Luigi Ferdinando Marsigli[1] was born in 1658 to a noble family from Bologna, the mater studiorum, the city with the world's first university,[2] the Archiginnasio. He received a wide range of knowledge from the teachers at its various colleges. It was characteristic of his interest in the natural sciences that in 1679 when he travelled to the capital of the Turkish Empire as a member of a diplomatic mission from Venice, in his luggage he brought along instruments for studying natural phenomena: a thermometer, a hydrostatic scale (to measure differences in the specific gravity of water samples) and a microscope (to study plants and seeds). He spent a full year in Istanbul, where not only did he attain a level of knowledge of the language necessary for communication, but he also became familiar with the inner workings of the Turkish Empire. He later used these experiences when he wrote his study on commerce (Marsigli 1701), as well as his book entitled *De Stato Militare*…about the military machinery of the Turkish state (Marsigli 1732). At the Turkish capital he made a decision that was to determine his future: to study mathematics and the science of military engineering, and to make a career in the military (Fig. 1).

When the Turks marched on Vienna the 24 year-old Marsigli was in Hungary in the army of the Emperor Leopold I. During the ensuing war that lasted 16 years he acquired a comprehensive knowledge of Hungary and the Balkans. During breaks in the war and when at winter quarters, he worked on the *Danubius Pannonico-Mysicus*. He went to great pains to have images appear with his textual descriptions, and therefore the work is exceptionally rich in illustrations.[3] (Fig. 2).

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[1] In relation to the spelling of Marsigli's name we note that recently his name has been consistently spelled *Marsili* in publications about him. However, during the period he worked in Hungary, he always signed his name on letters and reports as *Marsigli*. It was only later on that the version of his name lacking a "*g*" appeared. A few years ago in Bologna we were fortunate enough to meet with one of his descendants, who recounted that sometime in the 15th century the *Marsili* name appeared, but from a different branch of the famil. His surname is therefore correctly spelled *Marsigli.*

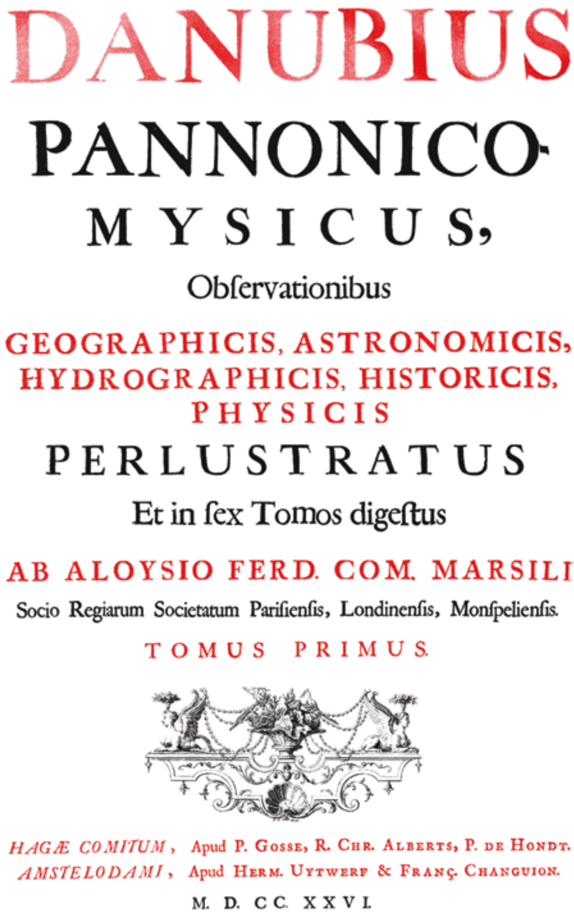
[2] Founded in 1087. Its cultural and educational influence spread over all of Europe. Following its example, universities were established throughout Europe: Oxford in 1170, Paris in 1200, Padua in 1222, the Sorbonne in 1257, Montpellier and Orleans in 1233, Rome in 1303, Florence in 1321, Pisa in 1343, Prague in 1347, Siena in 1357, Vienna in 1364, Cologne in 1388, and Leipzig in 1409.

[3] The peace treaty signed at Karlovitz in 1699 put an end to the war. The treaty entrusted the precise demarcation of the borderlines to a Turkish and an Austrian committee, who delineated them during onsite negotiations. The leader of the Austrian border demarcation committee was Marsigli. In the spring of 1702, Marsigli was ordered to the western front. He made it as far as Nürnberg accompanied by Müller, where he was the guest of Eimmart, the same Eimmart who accepted the task of engraving the illustrations of the *Danubius*. Here in Nürnberg he rented a room for Müller, whom he entrusted with overseeing the engraving, as well as preparing the renowned Danube maps, the 39 sectional border map, and the map of the countries of the Hungarian Kingdom. In February of 1704 a military tribunal announced that Marsigli was officially out of favour due to the surrender of Breisach Castle. When he afterwards went to France, he departed from Müller's life for good.

Fig. 1 Antonio Zanchi—Antonio Calza: Luigi Ferdinando Marsigli

The *Danubius Pannonico-Mysicus* is often called the Danube Monograph for short, or even the Anatomy of the Danube (Marsigli 1726). This latter name is most fitting, since the river is quasi-dissected. Marsigli examined and mapped its course and the pulsating veins of its tributaries. He noted all the components and accompanying elements of the great river such as its bed, banks, flood deposits and chemical constituents, as well as the life in it and around it, both flourishing cultures and those that had survived as legacies. His book was published in two versions: first in 6 volumes, and afterwards in 3 volumes. It measures 53 × 43 cm in a leather binding.

The author launched his work with a solemn foreword of relevance to the whole work. Referring back to the ending of his career in January 1704, he began with a question: *Would anybody have thought that this work would ever come to light after all the many vicissitudes of my life? Yet it has been realized, that which had seemed nearly unbelievable, nearly hopeless…* The turn in his luck was due to his journeys to England and the Netherlands, the original purpose of which was *to collect everything that had been missing for the foundation of the Academy of Science and Art of Bologna*. Later his Baroque eloquence was replaced by simple words. He spoke about the content of his work: *detexi, quod potui, in idemque congessi*, that is, I have explored everything I could, and collected it in this book. Paging through the book, we can share his conviction: Marsigli really did explore everything that he could and put it into words and pictures of artistic value.


DANUBIUS
PANNONICO-
MYSICUS,
Obſervationibus
GEOGRAPHICIS, ASTRONOMICIS,
HYDROGRAPHICIS, HISTORICIS,
PHYSICIS
PERLUSTRATUS
Et in ſex Tomos digeſtus
AB ALOYSIO FERD. COM. MARSILI
Socio Regiarum Societatum Pariſienſis, Londinenſis, Monſpelienſis.
TOMUS PRIMUS.

HAGÆ COMITUM, Apud P. Gosse, R. Chr. Alberts, P. de Hondt.
AMSTELODAMI, Apud Herm. Uytwerf & Franç. Changuion.
M. D. CC. XXVI.

Fig. 2 The title page of the Danube monograph

Volume I describes the environment of the Danube. Geographic and hydrographical aspects dominate in it, and a separate part is attached to the maps along with astronomical observations.

Volume II is very important for archaeologists since it contains the Roman monuments along the Danube.

Volume III concerns the minerals and mineral waters in the Danube region. It contains 7 large folio pictures and is illustrated with more than 330 drawings of the minerals discussed and 33 site plans (Fig. 3).

Volume IV describes the fish of the Danube and the animals living in the water, illustrated in 33 folios. Some of the fish species were described for the first time in a scientific way in this volume. The names of the fish are given in Latin, German, Turkish, Hungarian and Serbian.

Volume V is about the birds living along the Danube and their nesting habits. This volume contains the greatest number of illustrations, 74 large engravings, which are unique artistic representations of the various avian species.

Volume VI contains all the observations and descriptions that could not be organically incorporated into the first five volumes because of their topics, such as the expansion of the Tisza, or because of the specific method of description. This mixed and unconventional volume is often considered the most exciting part of the work. Its value is further increased by 28 folio pictures and 9 smaller engravings.

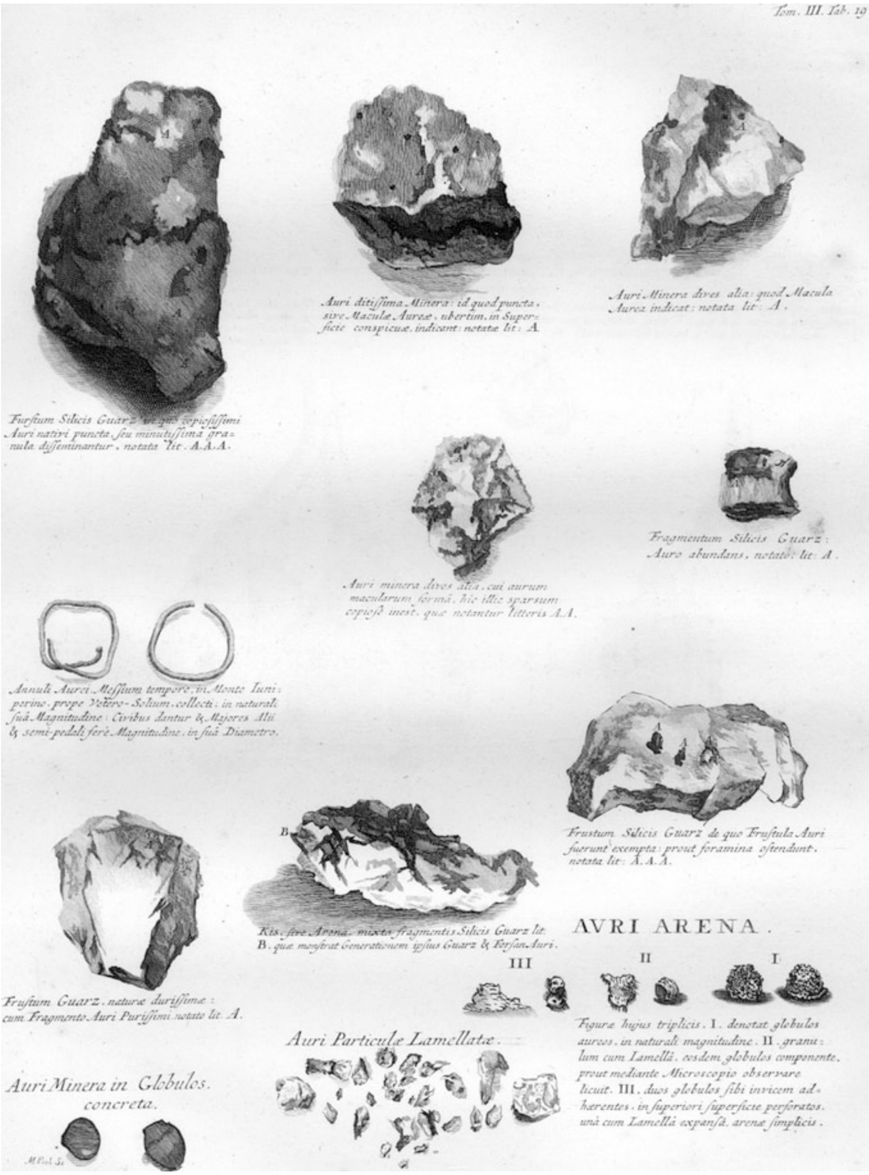


Fig. 3 Native gold from the mine

2 The Volume on the Minerals

2.1 Colleagues

Samuel *Rohfrey* (Samuel Rohfrey in Kreisbach) from Gyulafehérvár (Alba Iulia, Romania) sent Marsigli descriptions of the minerals and the mining districts of Transylvania (Rohfrey 1701). He replied to Marsigli's letter and request with the following statement: "*Transylvania is so rich in various ores that no European land can match it. Regrettably, however, there are very few people in Transylvania, who could exploit the treasures lying deep in the earth.*

The mountains hide metals in two regions. One, the mountains that begin at Gyulafehérvár and extend twelve miles over Körös-Bánya, is extremely rich in gold. The other one, from Kapnik toward Beszterce (Cavnic and Bistriţa, Romania) in the land of the Seklers abounds in silver. In comparison with other gold mines in Hungary, gold mining is unbelievably easy here.

There are also ore and copper mines, but these latter no longer yield much and have been abandoned. Antimony and cinnabar are also mined. And gold is washed from the rivers. The land is fabulous, not barren. There is little water in the mines except in those in the southern part of the region.

Yet, there is more salt in Transylvania than metal. Pure white salt, which is hard and heavy but dry, can be found in great abundance from Maramaros through Dés until the border of Wallachia and Moldva. It is often found exposed on the surface. There are many kinds of mineral waters, which can rival other European mineral waters in taste as well as in their healing powers."

Marsigli incorporated these pieces of information in his *Danubius*, similarly a report by an *unknown person*, who wrote about the sulphuric springs in Transylvania. The topic appears in the *Danubius* in the following way: *In Transylvania, near the small county called Drik, close to the village of Accida, there are bitter springs and cold baths beside them…, and a deadly hole can be found in their vicinity* (Marsigli 1726, Vol. I. Pars III.).

The letter from Ander Jacob *Schmidt*, a mining supervisor, also deals with mines. He sent a sketch of the mining establishments of Selmec (Banská Štiavnica, Slovakia) on a map following a survey on June 19, 1703 (with the names of 124 establishments) (Schmidt 1703).

The manuscript collection includes *Matthias Ethesius*'s ink drawings of 4 shafts, all from 1688: the *Scemnitzer Berg Chart,* the drawing of the *Herrengrund* without a title, the depiction of the *Ratzengrunder Bergwerk* and the *Polnitzer Eisbergwerks inheimische Grube* from Selmecbánya (Banská Štiavnica) (Ethesius 1688). The drawings are in colour and are illustrated with figures holding lamps, adzes and wheelbarrows, as can be seen in the mine depictions published in the book.

Francesco D. Maria Francia (Bologna 1657–1735) from Bologna, was given the most important task of all the Italian masters concerning the preparation of the *Danubius Pannonico-Mysicus*. Both Eimmart and Müller mention in their letters that the *Minerals* volume was engraved in Italy. However, they did not state the name of the engraver. We learn from Lelio Trionfetti that having seen the engravings, Müller expressed his great admiration for *Maria Franca*'s art, although he did not know him (Trionfetti 1703a). Another document mentions that Marsigli paid 100 liras to *Franza* (sic) (Marsigli nd). A three volume collection of engravings is kept in the Bibliotheca Universitaria in Bologna, composed by *Francia* himself from his *oeuvre*. Scattered over the free spaces of these volumes, Francia inserted some illustrations from the *Danubius*, verifying the evidence in the above argument (see for example Francia nd). Trionfetti, who seems to have been an intermediary between Marsigli and Francia, wrote in his letter of April 19, 1703 that Marsigli had also been very pleased with the prints that he had received (Trionfetti 1703b).

In relation to the maps, Marsigli's most significant colleague was Johann Christoph Müller (1673–1721), the Drafter of the Maps. He received his training in the German town of Nuremburg, which at this period in time was considered the scientific centre of all of Central Europe. Of his youth we know only what is disclosed in Doppelmayr's book, "Already in early childhood he showed evidence of his strong inclination towards science and art, and he acquired a thorough education in Latin and the humanities…" (Doppelmayr 1730). In 1692 in Nuremburg, under the guidance of Georg Christoph Eimmart (1638–1704), he acquired an in-depth knowledge of the arts of mathematics, astronomy and drawing (Doppelmayr 1730). He studied and worked alongside Eimmart for 4 years. He arrived in Hungary in 1696 at the invitation of Marsigli, where he was the right-hand man of this learned soldier in the organization of the Danube Monograph and in the drafting of the maps. The backdrop to his work, as with Marsigli, was the Austro-Turkish War (1683–1699). Until 1702 he worked in Hungary in the service of Marsigli, who fought in the war and then after the peace treaty was the imperial envoy for the demarcation of the borders. During this time Müller became an outstanding cartographer. He determined positions astronomically for his mapping of the Carpathian Basin. Utilizing these, he also drafted the maps indicating the country's mines.

2.2 *Sand and Stone in the Bed of the Tributaries of the Danube*

Marsigli started his substantial discussion of the topic with the microscopic analysis of the sand. The analyzed samples were collected from the northern bank of the Danube near Vienna, at Pest and from the sands of the Tisza above Szeged. He similarly dealt with the sands of the Maros, the Lajta and the Rába rivers. Then, he discussed the semiprecious stones, the less precious stones and ordinary stones. He illustrated these rocks in more than 150 drawings (Fig. 4).

The rich metal and mineral deposits carried by the tributaries on the left side of the Danube directed Marsigli's interest to the famous mines of northern Upper


5

MODIOLUS,
In suas Partes VI. divisus; ad Luti Arenæque inhærentis Proportionem cognoscendam.

ARENÆ DE DANUBIO;
ad Nusdorf, Magnitudo Naturalis. Per Microscop. visa.
Ripâ Septentrionali, prope Viennam, Magnitudo Naturalis. Per Microscop. visa.

Figura [Punctorum | Plurium Angulorum, Rotunda. | Figura [Punctorum | Plurium Angulor., Rotunda. } Figura.
Color [Cinericeus. | Argenteus. Flavus. Cinericeus. | Color [Cinericeus. | Argenteus. Flavus. Cinericeus. } Color.
Sapor { Exsiccatæ - Saponeus. Humidæ - Nullus. Lavatæ - Nullus.
Sapor { Exsiccatæ - Saponeus. Humidæ - Nullus. Lavatæ - Nullus.
Arenæ hujus Mensura, I., octies ex Aquâ clarâ elutriatâ 1/6 sui Parte, defecerat.
Arenæ hujus Mensura, I., octies ex Aquâ clarâ elutriatâ 1/6 sui Parte, defecerat.

ARENÆ DE TIBISCO;
supra Segedinum, Magnitudo Naturalis. Per Microscopium visa.
in viciniâ Segedini, Magnitudo Naturalis. Per Microscop. visa.

Figura [Punctorum. | Plurium Angulor. Rotunda. | Figura [Punctorum | Plurium Angulor. Rotunda. } Figura.
Color [Cinericeus. | Argenteus. Flavus. Cinericeus. | Color [Cinericeus. | Argenteus. Flavus. Cinericeus. } Color.
Sapor { Exsiccatæ - Terreus. Humidæ - Paludosus. Lavatæ - Paludosus.
Sapor { Exsiccatæ - Terreus. Humidæ - Paludosus. Elutriatæ - Paludosus.
Arenæ hujus Mensura, I., octies ex Aquâ clarâ elutriatâ 1/6 sui Parte, defecerat.
Arenæ hujus Mensura, I., octies ex Aquâ clarâ elutriatâ 1/6 sui Parte, defecerat.

Tom. III. C ARENÆ

Fig. 4 Sand in the bed of the Danube and Tisza

Hungary. He was lucky to be provided with an exceptional opportunity to get acquainted with the subterranean world, a world that the mineralogists he knew, never saw. He was allowed to descend into the mines and collect numerous rare rocks and ores on the recommendation of the emperor and with the friendly support of a count who supervised the operation of the mines. In addition, he developed fruitful personal contacts with the inspectors of the mines, which were to prove very useful for his book. Some samples of the minerals he collected at that time can still be seen today in the Museo Archeologico in Bologna.

He illustrated his method of exploring the topic with an example borrowed from anatomy: *if we want to present a man, he says, we usually first speak about his outlook, feelings* etc.*, and only then about his more hidden organs. Similarly, first we have to give a general picture of the minerals and only then can we proceed to the anatomy of the rocks* (Fig. 5).

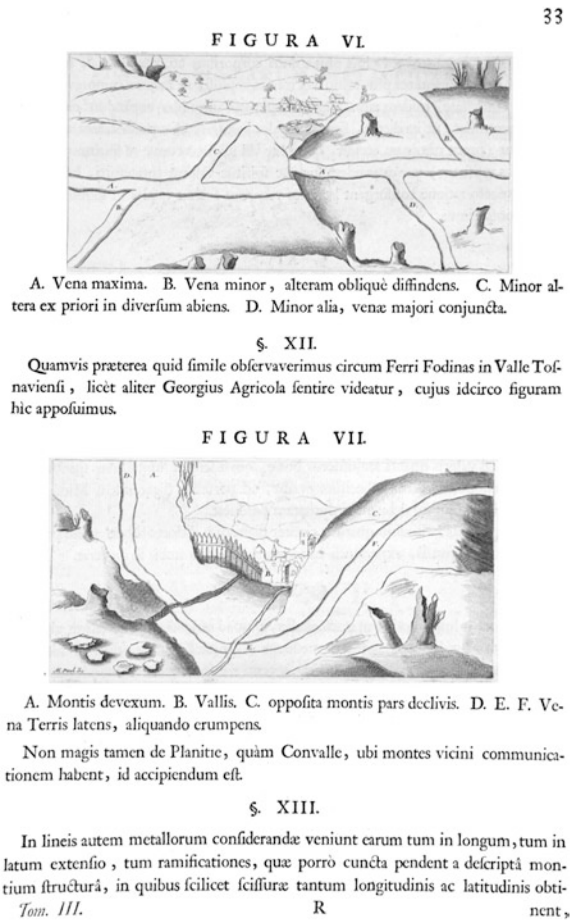

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FIGURA VI.

A. Vena maxima. B. Vena minor, alteram obliquè diffindens. C. Minor altera ex priori in diverſum abiens. D. Minor alia, venæ majori conjuncta.

§. XII.

Quamvis præterea quid ſimile obſervaverimus circum Ferri Fodinas in Valle Toſnavienſi, licèt aliter Georgius Agricola ſentire videatur, cujus idcirco figuram hic appoſuimus.

FIGURA VII.

A. Montis devexum. B. Vallis. C. oppoſita montis pars declivis. D. E. F. Vena Terris latens, aliquando erumpens.

Non magis tamen de Planitie, quàm Convalle, ubi montes vicini communicationem habent, id accipiendum eſt.

§. XIII.

In lineis autem metallorum conſiderandæ veniunt earum tum in longum, tum in latum extenſio, tum ramificationes, quæ porrò cuncta pendent a deſcriptâ montium ſtructurâ, in quibus ſcilicet ſciſſuræ tantum longitudinis ac latitudinis obtinent,

Tom. III. R

Fig. 5 The inner structure of the mountains

2.3 In the Mines of Selmec

The ore mines of northern Hungary and the salt mines of Transylvania had a particularly great economic significance. Understanding this, Marsigli paid great attention to presenting the minerals and mines found in the Carpathian Basin, although he justified this in his book by stating that the streams originating from the mines also transport rocks and minerals to the Danube. Due to the economic significance of the mines, their affairs were supervised by a so-called Treasury Count. Marsigli was only able to descend with his consent into the depths of the earth, where he was able to study the geological strata, collect rock samples and observe the work performed there. A mine chief named Schmidt aided him in his research work. Not only was he allowed to enter into the mines and bring up silver and gold nuggets, he also received all the information in which he was interested – about draft maps of the mine structures in Selmec (Banská Štiavnica) and on the surface, about the geographic location of the mines, about the directions of the galleries running in the depths of the earth and about the ores mined from these depths. Below the surface he also observed the stratification of the rock, which he then showed on the site maps in his book.

2.4 The Inner Structure of the Mountains

In 22 illustrations, this part of the *Danubius* contains a description of the declination of the rock layers (horizontal, oblique and vertical stratification) and the branching varieties of various metal ores (gold, silver, copper, iron etc.).

Not genuine rocks: In his description of *rock salt, petrified bodies and mineral salts* he primarily dealt with Transylvanian salt mines, and spent an astonishingly long time with them. The rock salt hills, such as the one that can be seen at Sófalu and the springs welling up from these hills intrigued him. He analyzed their waters and described the flames that soldiers had observed in 1685 above the marshes created by these mineral springs. He illustrated the cross-sections of the rock salt hills and the positions of the *flaming* springs of the hills (*situm fontis ignei*) in 12 pictures.

Among the *less valuable, larger rocks and crystals*, he discussed larger, soft and less valuable rocks; smaller but hard, less valuable rocks, larger valuable rocks such as crystals; and larger valuable rocks, which, as he said, were also called precious stones due to their value, and he enclosed 41 figures to illustrate them.

Of the *precious metals* he dealt with real precious metals, gold and silver, which he introduced in the form of various nuggets and dust. He described the famous gold and silver mines in northern Hungary, and incorporated his personal experiences and adventures within the description. He also wrote about less precious metals, such as copper and iron ore, and the waters coming from the copper mines in a separate chapter illustrated with 76 pictures. Among the *metals which were not genuine*, he discussed, among others, antimony crystals, mercury, and lead, together with 28 illustrations (Fig. 6).

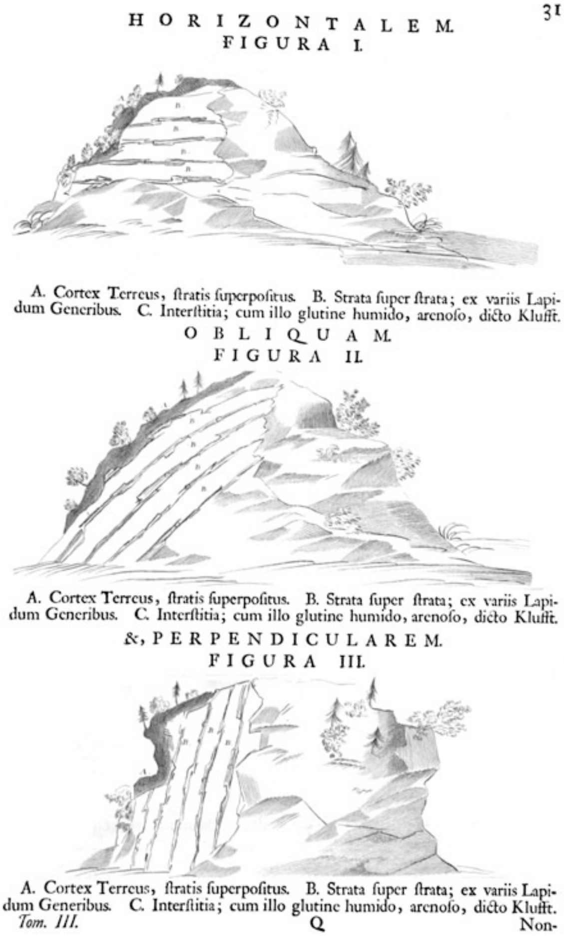

Fig. 6 The origin of the metals

2.5 Origin of the Metals

Marsigli tried to reconstruct the development of the metals from his observations of the structure of the rocks and mountains. He thought that the soul of the Earth's interior was expelled to the surface in volcanoes due to the specific arrangement of the rocks in the mountains where it solidified. A branched formation similar to the crater of a volcano is shown in the illustration. He hypothesized that all metals developed from the same exhalation which erupted from the abyss, and that only the circumstances which followed, determined what they developed into. He tried to support this idea with an analogy: as the sown seed of wheat can develop into pure cereal grain or turn into refuse wheat and weeds depending on the soil, sunshine and other circumstances, so it is with the materials that erupt from the depths of the Earth. Figure 2 of the four illustrations contains an interesting topographic detail. It shows the gold mine, the thermal baths and the medicinal springs between the villages of Zólyom and Ribar (Zvolen and Rybáre, Slovakia) in the valley of the Garam (Hron) River. All together, he depicted the rich world of rocks, metals and petrified materials in and around the Danube in nearly 350 illustrations.

2.6 The First Thematic Mining Atlases

Before everything else, it must be noted that, just as with the other maps appearing in the Danube Monograph, Müller also drafted the mine maps. Despite this, all of them must be considered the joint creations of Marsigli and Müller. After all, they were conceived by Marsigli, who in addition checked and sometimes corrected the first drafts made by Müller, a fact which can be easily verified in the borders of the maps, for example. Furthermore, the legends of the maps as well as the characteristic motifs appearing on them also attest to the assisting and guiding presence of the learned Marsigli (Fig. 7).

A summary map of minerals begins the description of the *rocks and ores found in the mines.* In this map he indicated the mines of northern and southern Hungary and Transylvania, from whence the rivers carried deposits into the Danube. The mountains in which mines were opened stand out with stronger hatching and small horizontal and oblong entrances drawn in their sides. The symbol beside them indicates whether it is a gold, silver, copper, iron, salt, mercury or lead mine.

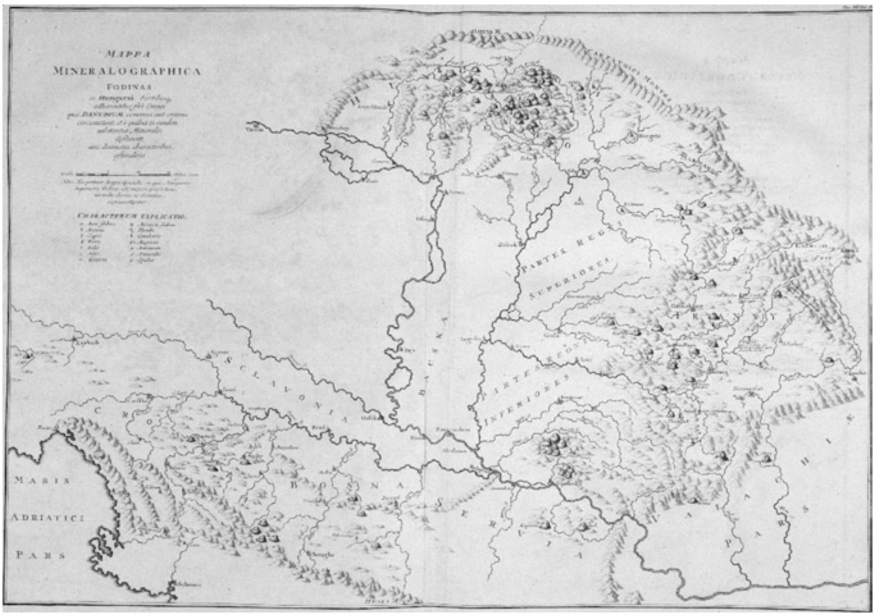

Fig. 7 The summary map of minerals

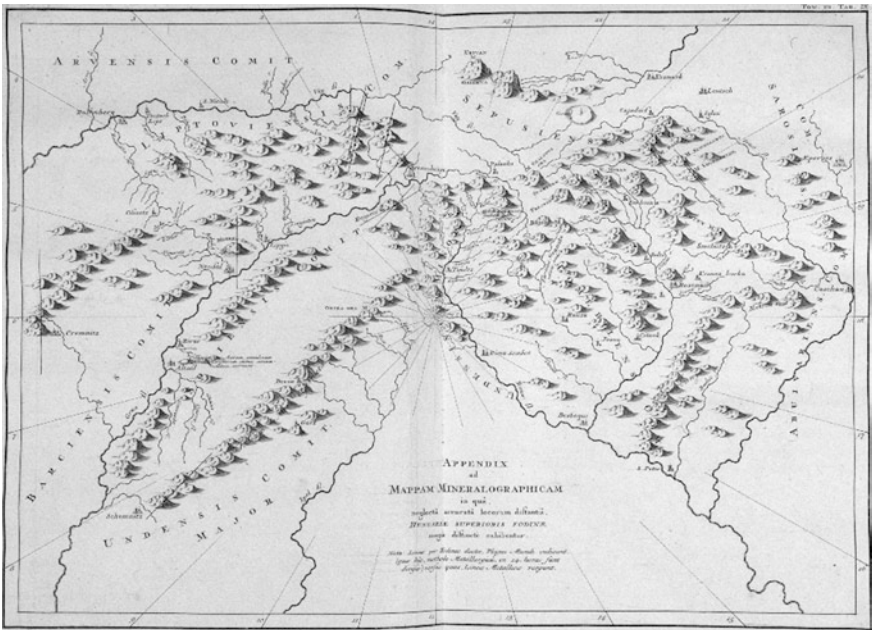

Fig. 8 Appendix to the map of minerals

[Inscription:]
Map of minerals,
which shows the mines of Hungary and its surroundings that lie either close to or far from the Danube and from which the rivers flowing into the Danube transport materials that are indicated by symbols
[The distances are indicated in geographic miles. Below:]
A special map belongs here that shows the mines of Upper Hungary in a greater scale, much easier to see and in more detail.
[Then the legend continues, using symbols borrowed from alchemy, introducing 14 types of mines: gold, silver, copper, iron ore, salt, garnet, mercury, lead, cinnabar, magnetite, antimony and opal mines.] (Fig. 8).

Then, another map follows of the same size, which was intended to be a supplement to the previous one. It shows the mines in northern Hungary on a larger scale, ignoring the actual distances between them. He drew straight sections through the mines so that he could indicate in which direction the ore veins ran in the individual mines. At the same time, he divided the whole field of the map by 24 straight lines numbered counter-clockwise, so that the aforementioned directions could be discerned from the angle at which they ran to these straight sections.
[Inscription:]
Supplement to the map of minerals, on which the mines of Upper Hungary are presented in greater detail, ignoring the careful indication of the distances between the sites.

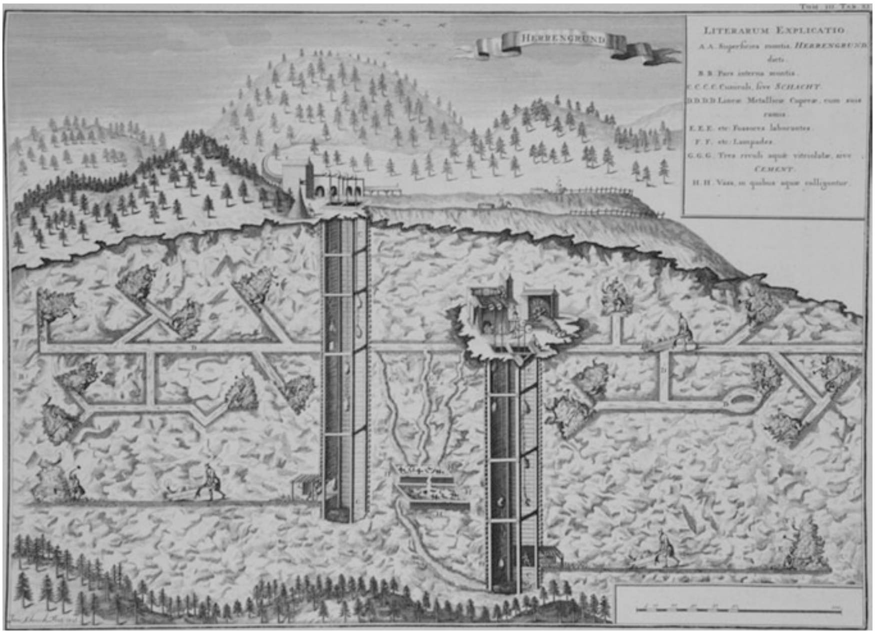

Fig. 9 The Herrengrund mine near Selmec

Note: The straight lines running through the mines show the cardinal directions (which here we have divided into 24 h *in the customary manner for mining), and the lines of the veins of ore run in comparison to these.*

We can find three famously well-drawn and suggestive drawings of mines under this heading. They show how the mines and their shafts penetrate into the belly of the mountain and how the miners worked down there (Fig. 9).

In the depiction of the mine with the legend *Herrengrund*, the mechanical constructions which hoisted the ore up the shafts to the surface can be seen. At the same time, it shows the cross-section of the ore-bearing mountain, the veins of metal ore, the galleries, the miners, the underground streamlets, the ponds in which these waters were collected and the channels that funnelled the water out of the hill.

[Inscription:]
Herrengrund
Explanation of the letter symbols:
A.A. Surface of the location called Herrengrund.
B.B. The interior of the mountain.
C.C.C.C. Galleries, or Schacht (mine shafts).
D.D.D.D. Veins of copper with their branches
E.E.E. etc.*: Laboring miners*
F.F. etc.*: Torches*

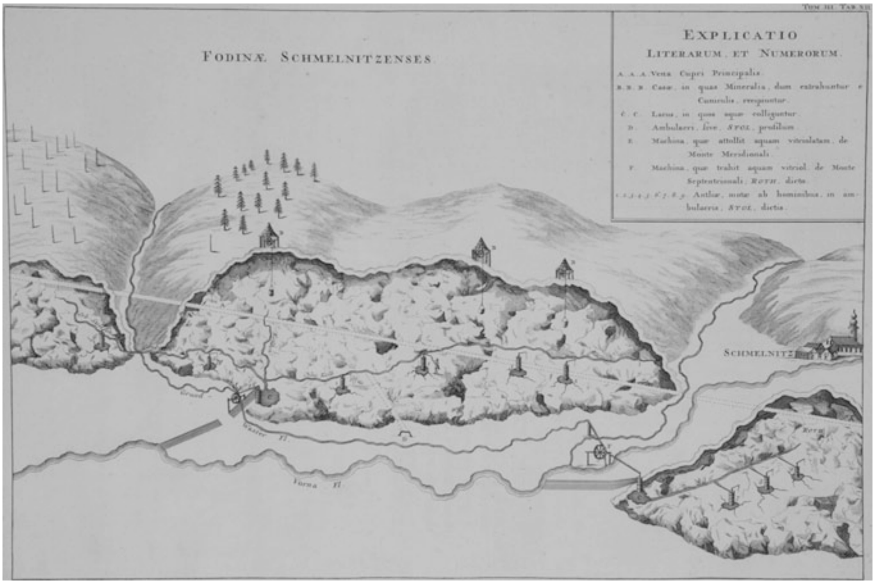

Fig. 10 The mines of Selmec

G.G.G. etc.*: Three streams of sulphurous water.*
H.H. Pool in which the waters are collected.

Figure 10 the other image with the legend *the Mines of Selmec*, illustrates the two water-lifting machines of the copper mine establishments. Water caused the greatest difficulties to the men who ran the mine. Due to the water they had to spend great sums of money on machines and horses, as they had to make many sacrifices to get rid of it. *The water is pumped day and night*, we can read here, *and if they stopped it, exploitation of the mine would become impossible. The first step is to collect the water. It is directed into ponds through channels, from where people try to drive it outside the hill through other channels*. If the surface did not allow this method to be used, it was pumped up using wheels. In 1695, when this drawing was made, the deepest point from which water was pumped lay at a depth of 110 feet. Naturally, intuitive and clever mechanics could be found there as well, he wrote with some malice. They spent considerable effort, in his words, *to replace people and horses with ridiculous contraptions*. Marsigli found their ingenuity *speculations* dubious. He put more trust in the water lifting machinery of a pulley construction that had passed the test in the mine. Yet, it was these same intuitive engineers who greatly contributed to the fact that the mine of Selmec was to become world famous in the following decades. For example, Sámuel Mikoviny's genuine water lifting machines and the early application of the steam engine in mines. The mine galleries, marked with dotted lines in the picture, ran nearly parallel in the real mines as well, following the veins of metal ore.

[Inscription:]
The Mines of Selmec
Explanation of the letters and numbers:
A.A.A. The primary vein of copper.
B.B.B. Buildings in which the minerals brought to the surface are unloaded from sacks.
C.C.C. Pools where the water is collected.
D. Cross-section of the gallery or Stoll.
E. Machinery that raises the sulphurous water from the southern mountains.
F. Machinery that raises the sulphurous water from the northern mountains, called the Roth Mountains.
1.2.3.4.5.6.7.8.9. *Pumps operated by men at the galleries called the Stoll Galleries* (Fig. 11).

It is the last of these site plans which is linked to my discovery. The illustration appeared in the 3rd volume of the Danubius. I found the manuscript original of this at the Marsigli Archives in Bologna (Dimensions: 45.5 cm × 70.5 cm). The description following the *map of the famous ore mine in Selmec in Northern Hungary* reveals that Marsigli was awed by the view of what he thought was the most famous mine in Europe (Marsigli 1726 Vol. III. p. 22). In the drawing he shows all the operations carried out as the veins of ore were followed deep into the mine in 1695. He was obviously enchanted by the way the ore and non-ore bearing layers were dug out, transported and lifted to the surface and how huge masses of water were pumped out. His description came from personal experience: *The surface of the hill is occupied by the town of Selmec and the multitude of shafts that the craftsmen covered with timber constructions. Down in the depths, the workers put the ore into leather sacks, which are lifted to the surface with the help of wheels powered by people or horses*.
[Inscription:]
Metallurgical map of Northern Hungary's famous mine of Selmec (Banská Štiavnica).
The mine serves to excavate the depths of the mountain, from which silver mixed with gold is mined, and which in its belly presents us with the following scenes:

Six hollows, called galleries in the technical language, run at different depths; the following can be seen in their cross-sections: machinery for removing the water; ladders for travelling up or down; leather sacks that they carry the mined rocks up, and we see people going up and down, as well as the name of each of the galleries.

The essentially horizontal lines running at various depths are galleries dug along the veins of metal ore where the miners and the people removing the ore travel: conduits run in these that transport the waters to prescribed locations, so that they can be more easily removed from the mine. Each gallery has been given its own name.

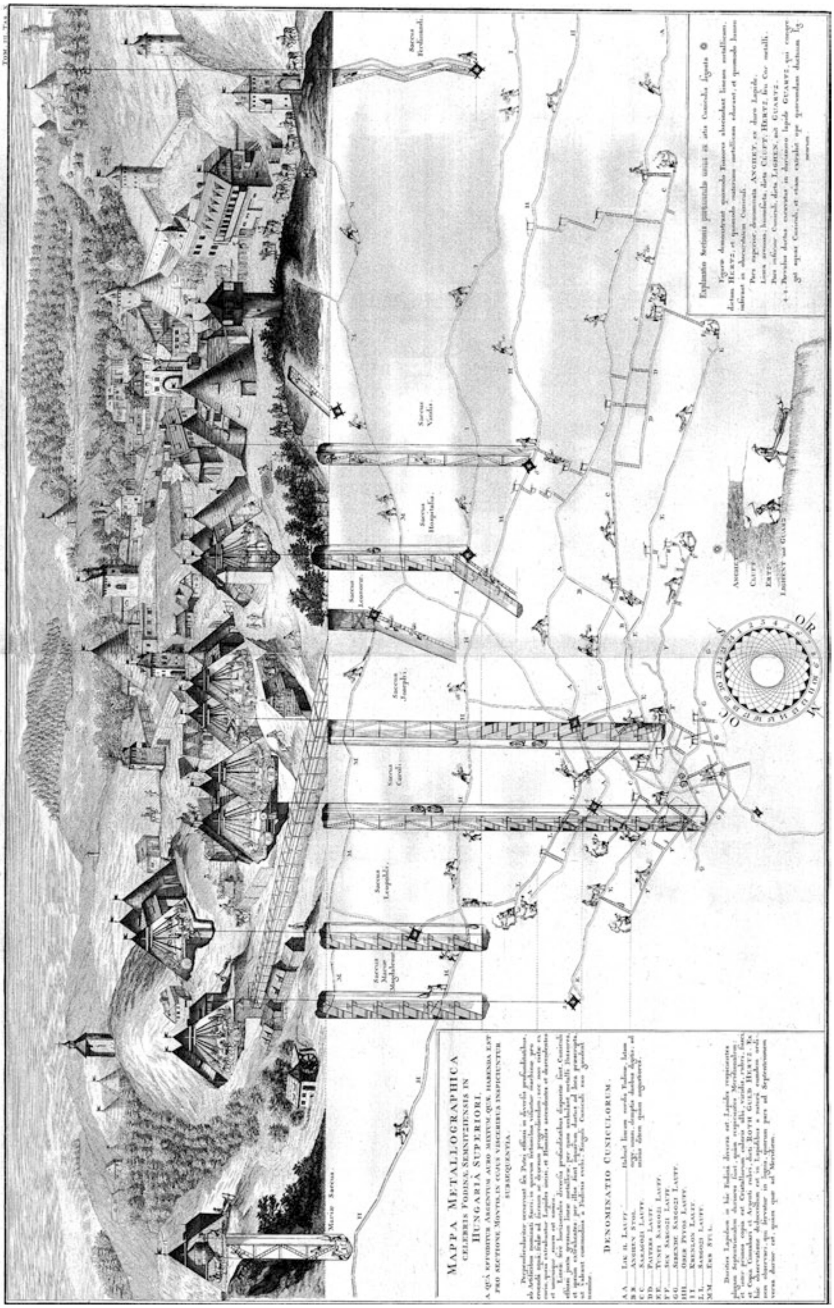

Fig. 11 Map of the famous ore mine in Selmec in Northern Hungary

The names of the galleries:
AA……………..Lik II. Gallery. It ran along the center line of the mine, it was two inches shy of one fathom wide; it can be considered a narrow rather than a wide gallery.
BB……………Anghen Gallery
CC……………..Saragozi Gallery
DD……………..Paiters Gallery
EE………………Tunfi Sargozi Gallery
FF……………. Hat(os) Sargozi Gallery
GG…………. Hetedik Sargozi Gallery
HH………….Felső Pitos Gallery
II…………… Krenlon Gallery
LL……………..Sargozi Gallery
MM………… Adit (Erb Stul) [Erbstollen]

The hardness of the rocks in this mine varies. The rock to the north is harder than that to the south; and amongst the former white, green, red and opal are common, and there is a lot of cinnabar and red silver, which can be considered red gold ore. From this observation it can be concluded that nature has preserved the same order in the rocks as in the trees, which are of harder wood in the northern section than in the southern.

[In the lower right-hand corner:]
The small cross-section of the gallery depicted above that is indicated with an asterisk:
The figures show how the miners dig out the vein, which they call Hertz, and how they transport the ore out as well as how they lit up the dark gallery with their torches.
The upper section, which they call ANGHET, is made of hard rock.
Drenched gravelly stripe, which they call CLUFT or HERTZ, or in other words the heart of the ore.
The lower section of the gallery, which they call LIGHEN, or QUARTZ.
4.4. *Small ditch dug out of the hardest QUARTZ rock, which collects the waters of the gallery and drains them through wooden conduits placed in it*

Following this, I turn my attention to the surprise that I received in Selmecbánya (Banská Štiavnica) a few years ago. On the occasion of a conference in memory of Sámuel Mikoviny (the name of Mikoviny is well known to those who deal with the cartographic history of Hungary) I stumbled upon an extremely weather-beaten site plan at a temporary exhibit in the museum. I could hardly believe my eyes. I was standing in front of a perfect copy of the manuscript drawing of Selmecbánya I had seen in Bologna. Even its dimensions were the same. The caption under it revealed that the exhibitors had no information about the history of the drawing.

Based upon what has been reported, the history of the illustration can be reconstructed in the following manner:

Marsigli—as was his habit—recorded what he saw in a draft sketch. From this J.C. Müller compiled the illustration which was the basis of the engraving for the image appearing in the Danube Monograph. As a token of his appreciation to the Treasury Count residing in Selmec (Banská Štiavnica) that supervised the mines, he had Müller prepare a copy of this attractive drawing as a gift. This is how it may have wound up (following a great deal of hardships judging by its condition) in the Records Office of Selmecbánya.

During the course of our research work we were not able to reveal every mystery about the history of the creation of the Danube Monograph. This is also true about the volume of this work dealing with minerals. We were able to discover that the copperplate engravings of the minerals were made by the master Francia of Bologna, but we do not know upon whose drawings they were based. We suspect that Müller gave these their final form, just as with the site plans and maps. Our justification for this hypothesis is that we found numerous pieces of evidence in the Marsigli estate that Müller, as Marsigli's personal secretary, actively participated in the completion of the manuscript, some believe the final framing of the Latin text was also his work. At the same time we also know that in Nuremburg alongside Eimmart, he gained expertise in the art of drawing, which is reported by Doppelmayr, so he would have been able to depict the minerals with artistic skill. As has been mentioned, the final framing of the maps must be clearly attributed to Müller, but we do not have any definite knowledge about who made the relevant copperplate engravings. Based on the fact that Eimmart made the engravings for the maps in volumes I, II and VI, with the exception of the 18 section drawings of the Danube, we can postulate that the maps and site plans for the volume on minerals, volume III, and therefore all the maps of work, were given their final forms in his workshop.

In conclusion we consider it proper to briefly commend Marsigli's brilliance as a scholar. If one would page through the six volumes of the Danubius, one could ask the following question: How was a soldier who, from spring to autumn, played an important role in military campaigns (rising all the way to the rank of general) able to produce this sort of accomplishment? The excellent organizational skill of the author provides an answer to this as he maintained contacts with nearly every significant scholar in Europe. On a scientific level the Danube Monograph serves even today as an example embodying the spirit of the European Union! At the same time, originality was not lacking from his intellect. Thanks to this, he is considered a father of numerous fields of study. The maps of volume III presented above have been designated with the title of "the world's first thematic mining atlas" (Török 2006). However, similar worth is represented by the maps indicating Roman antiquities (Marsigli 1726 Vol II), and the first thematic commercial map surviving in the manuscript, which outlines the commercial possibilities of Hungary following the Turkish wars [see Deák (2006)]. The inscriptions and legends of Marsigli's thematic maps by themselves raise them to the level of important scientific sources. Of these, the mine maps represent outstanding assets. The words Marsigli used when sending the Danubius on its way can also justly refer to these: *I was the first to shed light on this distant and secret world hidden in barbarian obscurity.*

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Author Biography

Antal András Deák (born 1941) is a senior researcher at the Danube Museum in Esztergom, Hungary. His main research area is technical history and history of the cartography. His most important publications are Hungarian Fishes and their Fishing from Mathias Bél (Budapest 1984); Designer of the Hungaria Nova: Samuel Mikoviny (Budapest 1987); Catalog of the Széchenyi Documents in the Danube Museum (Budapest 1990); and From the Triangulation to the Regulation of the Tisza (1996). In his last two works he elaborated the life, research work and activity of Luigi Ferdinando Marsigli and Johan Christoph Müller in the surveying and mapping of the Danube and of the border line between the Turkish and Austrian Empire after the peace treaty of Carlowitz. To this extent, he researched the Marsigli-Archive in Bologna and the archives in Vienna. He published the results of this research in two volumes: The Discovery of the Danube (Budapest 2006) and Maps from under the Shadow of the Crescent Moon (CD-ROM, Budapest 2006; the same work was published in book with a CD-ROM. Esztergom 2007). He published the history and the maps of the famous surveying of the Danube in the first half of the nineteenth century on a DVD-ROM (Duna Museum 2010).

The Long Life of a 1:200,000 Map of Central Europe and the Balkans

Jean-Luc Arnaud

Abstract In the mid-1880s, the geographical service of the Austro–Hungarian army (the *König und Kaiser Militargeographisches Institut*), which was well known for the quality of its production and the how-know of its staff, started the publication of a new map of Central Europe and the Balkans at a scale of 1:200,000. This cartographic series is peculiar in the sense that it was used, copied and translated by most European armies for more than a century. In fact, it is one of the most complicated and huge series ever to be published. For a key map that has only 265 boxes, more than 6200 different sheets were published in 56 series. This chapter deals with the methods which were developed to make the inventory, to construct the corpus (from 17 collections), and to identify the criteria for sorting the lists.

1 Introduction

Throughout the nineteenth century, the Balkan Peninsula was at the heart of political issues. Several countries vied to extend their authority over the new states to which the Ottoman Empire had given birth. In this context, that part of the world numbers among the most mapped regions. The Austro–Hungarian production had a head start on others. Over the course of the second half of the eighteenth century, the Austrian Army acquired highly valuable skills in terms of detailed cartography (Kretschmer 1991; Janko 2007, 85–117). A century later, building from this experience, it published a first map printed at a scale of 1:75,000. There were no less than 760 sheets. Many cartographic series at different scales and perimeters were to follow. That is only the first of a long list of cartographic series at different scales and which perimeters largely transcended the one of the Dual Monarchy. This production became the matrix of a large part of the Balkans and Central Europe cartography until the end of the Second World War. The longest and the most troublesome history behind the making of a series was probably the series at scale of 1:200,000. The 265 sheets covered most of the Balkan Peninsula and a large part of Central Europe.

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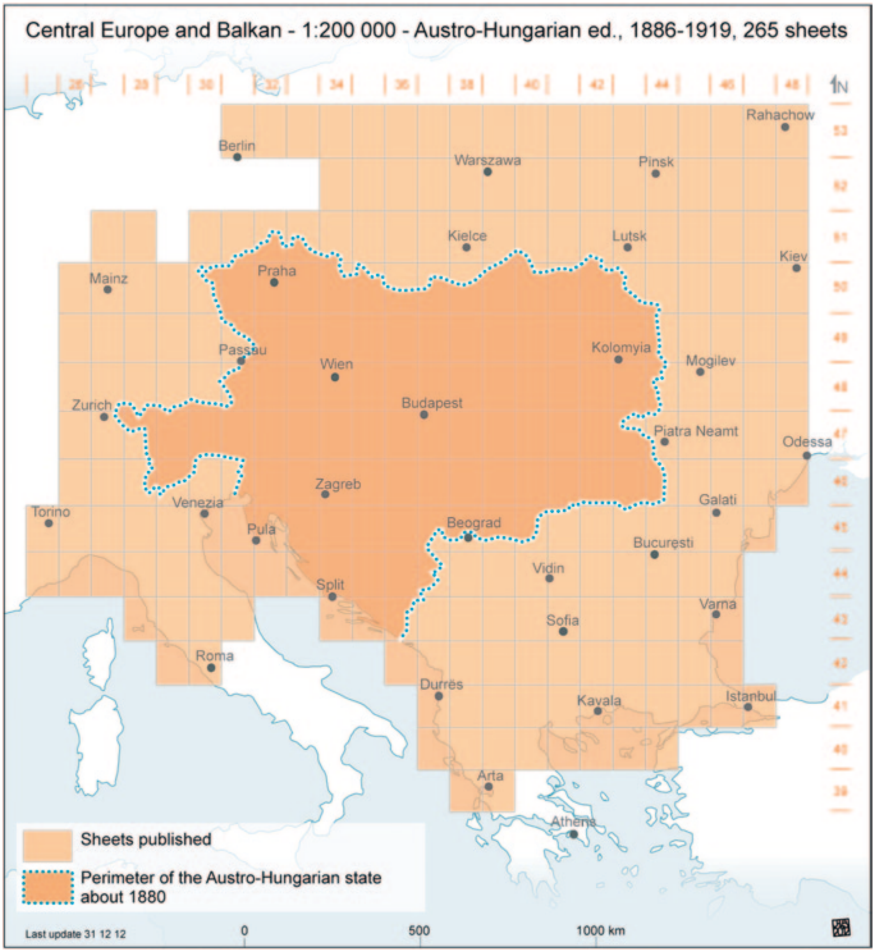

Fig. 1 The perimeter of the series largely exceeds the borders of the Austro–Hungarian Empire. More than half of the sheets—160 of 265—represent territories outside of the borders

This chapter is devoted to this map. In many respects, the latter proves to be exceptional to say the least. Right from the first inspection of the collections, everything seemed strikingly beyond measure (Fig. 1).

2 A problem of Size and Complexity

What is particularly unusual about this map is the number of documents held. Although the sheet index has only 265 boxes, several collections are huge. The first consultations quickly revealed that this map had not only been published by

Austro–Hungary, and not just until 1920. Indeed, it was used during the world-wide conflicts by several European Armies. During the Second World War, the German and the Austro–German editions seemed huge. French, Hungarian, Czechoslovakian, and Yugoslav editions could also be found. After examining the collections, several thematic editions were revealed: road maps, aerial maps, and administrative maps, and in the early 1940s, several ethnographic series, were published in Vienna on behalf of the Reich. This first assessment allows an understanding of why the number of different sheets held is so numerous compared to the number of boxes on the sheet index. The successive inventories of different collections pointed to the fact that the increase in the number of editions is not the only explanation.

A second peculiarity lies in the contents of the original series published by the Austro–Hungarian Army. In these series, several sheets had been checked and updated so many times that there were up to four different versions published in the course of the same year. Thus 2817 different sheets have been counted for this edition, which on average corresponds to more than 10 editions for each geographical unit.

2.1 Size

The collections of 17 establishments have currently been catalogued. This work has been carried out with the collaboration of Robert Banfi, Isabelle Cloître, Bernadette Joseph and Marine Valois. Through these collections, more than 10,000 documents have been consulted. These correspond to 6,200 different sheets divided into 56 series. The oldest sheet dates back to 1886 and the latest to 2000 (part of an Austrian road map composed of 23 sheets).

This work is still in progress. Although the number of documents consulted is huge, it is clear that the catalogue of sheets is still incomplete. It is obvious for the series in which sheets are numbered, and in which several documents are clearly missing. If the catalogue is now complete regarding some series composed of less than a hundred sheets, the lists are still to be completed for the others. The stock is obviously enormous but the collections do not always occur where they are expected to be. For example, the Italian edition from 1940 could not be found at the Geographical Military Institute of Florence (*IGMI*). As far as the collection of the French National Geographic Institute (*IGN*) is concerned, it only holds 242 sheets out of the 329 mainly funded and published by the French *Service Géographique de l'Armée* (SGA) between 1916 and 1919. On the other hand, the *IGN* holds a dozen of the sheets missing in the collection in the Military Museum in Budapest of the Hungarian edition. At last, more than a year after a fruitless trip to Vienna, to the National library and State Archives in Vienna, I discovered that the archives of the *Bundesamt für Eich und vermessungswesen* (BEV) holds more than 3,000 sheets at scale of 1:200,000. These maps have not been consulted as yet.

2.2 Complexity

The peculiarity of this map is thus confirmed, but this is not only a question of size. The numerous editions make the matter even more complex. Indeed, these maps were often designed in a hurry as the war circumstances dictated, and by very diverse services. We have chosen to study this specific map because we consider it to be one of the most complex series ever published (These lists of sheets were used to check the functionalities of the *CartoMundi* Website: http://cartomundi.eu). Each step of the study in progress supports this hypothesis.

Thus, this complexity is not the result of a mere inductive approach by a researcher who was previously unfamiliar with the world of military cartography. The main persons in charge, the Austro–Hungarian militaries themselves, encountered difficulties in managing so many documents. The complexity of this map is still a problem. It has been widely distributed and numerous libraries hold large collections of it. However, amongst the 17 collections researched, it appears that most of these collections are organised according to the titles or to the numbers of the sheets without taking serial classification into consideration. For example, at the IGN, cupboard 82 encloses 16 files gathering 1971 sheets classified by numbers. These maps belong to 26 different series. Yet, how could it have been different in the present state of our knowledge? Some series are not easy to identify. When there are only a few sheets of a series in a collection comprising more than 1000 documents, the differences that allow a comparison and an elaboration of the criteria used to define a series, are very rare. It is only by putting together and comparing the lists of sheets held in different establishments, that we have been able to identify some series.

2.3 Organizing the Complexity

The first goal of our work was to organize the complex aspects through an index of series. For each, pieces of information are specified: the editor, the publication date range, the number of corresponding geographical units, and the subject for thematic maps. Some discriminating pieces of information are also specified such as the title of the series, the language, the layout, the numbering system, and the prime meridian of the coordinates. Those few criteria allow the creation of coherent groups and to make a distinction between the different editions. This index could not be made without the lists of sheets, which is the reason why the research first focused on the editors' publications and on the library catalogues.

As far as the editors were concerned, militaries, for the most part, were often unwilling to provide information they regarded as strategic. However, from 1881 to 1918, the cartographic service of the Austro–Hungarian army published annual reports (*Mittheilungen des Kaiserl. Königl.* 1887). Each report sets out the progress of the work on the different series available. Of particular interest to this chapter, the sheet indexes for every year indicate the position of the published sheets and of the sheets which were being published. As these reports display only the geographical distribution, they are not detailed enough. They do not present lists of sheets and it is therefore not possible to build any lists from this documentation.

The investigations in the map libraries were also not fruitful. In all the establishments where collections have been located, this map has never been properly catalogued. This situation attests to the complex aspects of this map and the difficulties encountered by the librarians who had to organise the collections. In most cases, the sheets are listed in a particular register according to their number, title and date only. However, this form of recording is not detailed enough and not feasible for this kind of series. The result was that we could not find any library listing of the sheets of this map which were published by the Austro–Hungarian Army or its successors.

3 Establishing the Catalogue

In this context, the only solution was to make a list of sheets held by the 17 establishments. The collection of the National Geographic Institute in Paris constituted a first base. This collection is the largest available in France, containing 1,600 sheets. Our first attempt to catalogue this collection followed the international standard. As there was much to do, we had to work fast. Indicating all the particulars of each sheet, was not a priority. At this stage, we had not yet assessed the complexity of this map. With this collection, we thought we had a large part of the published sheets at our disposal. However, as this first cataloguing process was in progress, the principles adopted proved to be ill-adapted. A standard cataloguing system did not allow us to resolve all the ambiguities, nor to differentiate between documents which differed. New complementary criteria for description had to be introduced. The most important problems concerned the definition of the responsibility, the dates and the identification of variations.

3.1 Definition of Responsibility

Numerous sheets make no mention of responsibility, which made it impossible to find the editor who was in charge. This situation compelled us to gather all the pieces of information indicated on each sheet. For example, several sheets showed a date transcribed as: *Tiparit in anul* 1914. In Romanian, This means "printed in 1914". The corresponding sheets were allocated to the corresponding Rumanian edition. As far as the first French edition is concerned, no specific responsibility is mentioned. Most of the sheets are verbatim copies of the original edition. All the annotations in German have been kept. On this basis, the copied sheets were first attributed to the original edition. The few sheets which mention the *Service Géographique de l'Armée* (*SGA*) are, however, peculiar in that they have three colours whereas the original has four. The means of reproduction used by the French army were so poor that it was easier to identify the edition from the quality of the printing. Relying on the correspondence between this production, on the one hand, and the *SGA* publications on the other hand, the published sheets with the same characteristics were finally allocated to the French edition.

3.2 Dates of the Sheets

When two sheets represent the same geographical unit and are published by the same editor, the date is the most discriminating criteria. According to the standard, the most recent date is taken into account.

However, in the early years of the century, editors often published the same sheets several time in the course of one year. Some sheets show the same final date of edition, but the earlier dates are different. Some dates are also similar, but occur in different statements. For example: a sheet with *Teilweise berichtig bis 6.IX.12*, and another with *Nachträge 6.IX.12* are almost synonymous. They correspond to the date the document was updated, but the different presentations and positions attest to numerous numbers of versions.

To expose these differences, specific notes have been introduced in which the mentions of dates are indicated chronologically. When there are sentences or words with the dates, the original wording and the language of the specific annotation have been kept. Its position on the sheet has been added in square brackets. It is now possible to discriminate between sheets which, without any notes, would look similar.

Two editions during the same year, sheet *Cassel* (27° 51°), 1899

- *1899* [bottom right]
- *1899* [bottom right]; *9.20./6.* [20 06 1899, bottom right]

Differences in the dates, sheet *Florenz* (29° 44°), 1916

- *1905* [bottom right]; *Nachtr. 16.III.1909* [centred at the bottom]; *20.VI.16* [bottom left]
- *Teilweise berichtigt bis 29.III.1915* [bottom Right]; *20.VI.16* [bottom left]

Differences in the printing of the dates, sheet *Balta* (47° 48°), 1939

- *28.VI.32* [bottom left]; *VIII.XXXIX* [bottom right]
- *28.VI.32* [bottom left]; *1939* [bottom right]

For each sheet, the observation of the list of dates—there can be up to four—allows the finding of the genealogy of each sheet and to follow its successive changes. For example, regarding the sheet Proskurow (45° 49°) from the original version:

- 1890. *1890* [bottom right]
- 1891. *1890* [bottom right]; *Nachträge 1891*
- 1892. *1890* [bottom right]; *Corr. 1892* [bottom left]
- 1896. *1890* [bottom right]; *Corr. 1895* [bottom left]; *27./5. 96* [bottom right]

Or, during the First World War, sheet Czernowitz (44° 48°):

- 1915. *Teilweise berichtigt bis 13.IX.1915* [bottom right]
- 1915. *Teilweise berichtigt bis 13.IX.1915* [bottom right]; *7 XII 15* [bottom left]
- 1916. *Teilweise berichtigt bis 13.IX.1915* [bottom right]; *22.IV.16* [bottom left]
- 1916. *Teilweise berichtigt bis 13.IX.1915* [bottom right]; *13 V 16* [bottom left]
- 1916. *Teilweise berichtigt bis 13.IX.1915* [bottom right]; *14.XI.16* [bottom left]
- 1917. *Teilweise berichtigt bis 13.IX.1915* [bottom right]; *8.X.17* [bottom left]

The list of dates allow the editions to be related to one another. Thus the annotation *Reszeben Helebitve* followed by a date can be found on several sheets of the Hungarian edition. This annotation means "up to date" and is equivalent to the annotation *Nachträge* or of *Teilweise berichtigt bis* in German. The sheet *Josephstatdt* (34° 50°) dated 7.X.18 and published by the *Militär-geographisches Institut* in Vienna, is related to the Hungarian edition published by *M. Kir. Állami Térképészeti Intézet* (Hungarian Royal Institute for Cartography) in Budapest. It shows the annotation *Részben helyesbítve 1918.X.7*. The similarity between the dates means that the two editions are related, but it does not provide any information regarding the way the matrix went: out of Vienna/into Budapest or out of Budapest/into Vienna.

The map of Austrian borders in 1937 is another example of this dating problem. The map was made by overprinting on sheets from the topographic edition. All the sheets bear the following generic title: *Stand der Grenze* 1937 (Frontiers in 1937), overprinted in red. The edition has 21 sheets that indeed correspond to the lines of the Austrian frontiers at the date mentioned. On the face of it, it seems to be an edition dating back to 1937. However, the dates mentioned on several sheets reveal that it is not as simple as it looks. Indeed the topographic background is dated as follow: from 1934 to 1946. Actually, this map is an historical edition which deals with the lines of the Austrian frontiers in 1937, that is to say, before the union (*Anschluss*) with Germany. Published at the end of Second World War, probably in 1946, it documents the demarcation of the Austrian territory so as to redefine the frontiers after the Austro–German alliance was defeated.

Several German editions also help to expand knowledge about dating problems caused by overprinting. The German army published a thematic edition of the Bosnian–Herzegovinian roads around 1944. It was made by overprinting in purple on a topographic base map. The order of the printing processes cannot be changed. The background is always printed before the thematic data. Yet, for some sheets, the statements of dates relating to roads, indicated as follow: *Überarbeitet* [*III* or *IV*] .44 [Revised…] are earlier than the date of printing of the topographic base. They are transcribed as follow: *Druck : X.44* [printed in X. 44]. The dates of aerial photographs used for this updating are from 1940 to 1943. In this context, the apparent reversal of dates led us to believe that the date printed in purple corresponds to the period during which the routes were checked and that its final version had been printed at the end of the year 1944, or perhaps even a few months later.

3.3 Identification of Variations

As from 1936, the Austrian (Federal) Service of Metrology and Topography (*Amt für Eich—u. vermessungswesen/Bundesamt für Eich—und vermessungswesen—BEV*) has published a civil version of the map at a scale of 1:200, 000. The most recent sheet dates to 2000. There are certain similarities between the sheets if we use standard descriptive data. On the other hand, if criteria such as the way sheets are numbered, the prime meridian of geographical coordinates (Ferro Island/Greenwich), the title of the series, the layout of sheets, or the repetition of some, are combined, some differences appear which concern all the sheets published by *BEV* among 11 different series.

Some other variations are not that systematic. They cannot be used as a criterion to differentiate series but they can be used for individual sheets. These are details such as a missing edge, a peculiar annotation, the partial erasing of an annotation on the matrix, a complementary number or even—the most insignificant example encountered—a letter in upper-case in one version and in lower-case in another.

Sheet *Oppeln* (36° 51°), 1914

- *teilw. berichtigt bis 5. III. 1913* [bottom right]; *1914* [in bold letters, centred at the bottom]
- *Teilw. berichtigt bis 5. III. 1913* [bottom right]; *1914* [in bold letters, centred at the bottom]

As has probably been understood, numerous details of all kinds can be used in discriminating. However, a list of these can only be made after the cataloguing has been completed, and it is not possible to make a comprehensive description of each document. In addition, a difference as insignificant as a letter in lower case could be the result of an error in data entry. As the collections are very scattered, it is not possible to compare or to increase the number of checks for each question the conflict between sheets held in different establishments raises. To overcome this difficulty, we have reproduced documents to allow is to make checks *a posteriori* (Fig. 2).

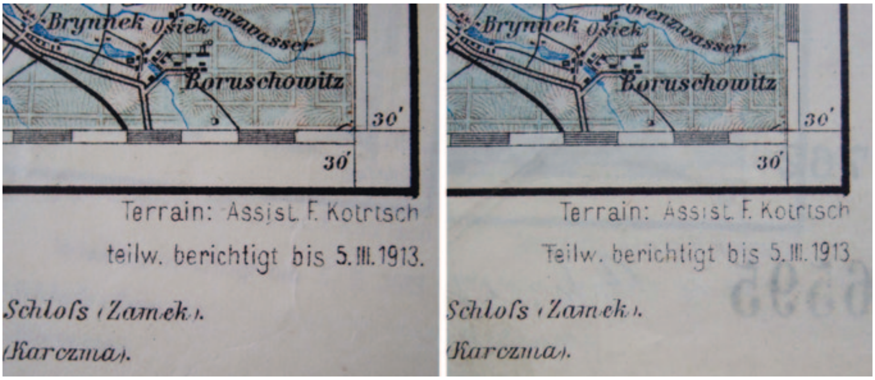

Fig. 2 Sheet *Opeln*, two versions for the same statement. The two corresponding sheets are held in different collections. The first (on the *left*), is in the National Library of Ljubljana University, file: Z 204-40. The second (on the *right*) is in the *Staatsbibliohtek* in Berlin, file: Kart. F 6595

4 Building the Series

The first list of sheets (all series taken into account) was classified according to geographical units. For each box of the sheet index, the different versions were organised chronologically. To make a first gathering of the sheets by groups (editions), we first used the contents of the list taking into account several elements from the description of the sheet: the subject, the language, the mentioning of responsibilities, the layout etc. On the basis of this first work, several series or groups of sheets were identified. Yet, it did not allow the resolution of all the ambiguities. To refine the result, the geographical location of each group of sheets was considered.

4.1 First Classification

To build the series on this basis, we firstly separated the thematic maps of which the layout, and/or particular statements on the maps, resolved all ambiguities. For example, the sheets corresponding to the four ethnographic series (n° 29–32) published under the authority of Wilfried Krallert in 1941 in Vienna were easily identified. The maps of fortifications—*Befestigungskarte* (n° 33–36)—were also easily located and put aside. Then, we took into account the proper title of the series, if available. Several German editions were identified according to this principle: *Generalkarte der Tschechoslowakei* 1:200 000 (n° 20) and *Mittel- u. Südgriechenland* 1:200,000 (n° 24), a French edition: *Europe centrale* 200,000*e* (n° 19) etc. Two groups of sheets were identified which bear proper titles that were similar, but also different:

Generalkarte von Mitteleuropa 1:200,000 and *Generalkarte von Miteleuropa Balkan* 1:200,000 (n° 25). I will return to this example later.

We also paid attention to the dates of the sheets and their possible gaps to differentiate some series. For example, the sheets in Rumanian were published between 1914 and 1939. Their chronological classification testifies that no sheet was published between 1921 and 1929. In fact, they can be divided into two periods: a first period from 1914 to 1920, and a second from 1930 to 1936. We considered each period as corresponding to a particular series. Following the same principle, we succeeded in differentiating the Austro–Hungarian edition from the subsequent Austrian one. The dismantlement of the Austro–Hungarian Empire began with the armistice of November 1918, but Austria was officially founded by the treaty of Saint-Germain in July 1920. Between these two dates, the sheets at a scale of 1:200,000 published in Vienna either bear the statement of responsibility: *K.u.k Militärgeographisches Institut*, or an annotation mentioning the Austrian service which succeeded it: *Militärgeographisches Institut*. The dates of the sheets and the volume of the annual production were used to define the end of one series and the beginning of another. Whereas there were 130 sheets published in 1918, there were only 5 which were published between January and July onwards 1919. Publication slowly resumed in 1920, with 8 sheets published from March onwards. The production was interrupted for 7 months. The date we chose to define the limit between the two series corresponds to this period.

4.2 Geographical Location

The classification of the sheets has allowed the creation of a first list of series. In this list, each series occupies a line and are all equally important. The study of the catalogue points to marked differences though. Whereas there are more than 2,800 sheets published for 265 geographical units with the original edition, the series of the ethnography of Slovakia consist of 9 sheets only. Between these two extremes, the other groups contain a variable number of geographical units. On the basis of the layout of the original series, the list of units represented for each identified series has been copied out.

Beyond this copy, the presence of the geographical zone represented by each group of sheets is a tool to improve its definition. If we work on the principle that the production of each group results from the desire to homogeneously display a given geographical zone, index sheets allowed the completion of some groups or to associate some or to share some others (Fig. 3).

First of all, the sheet indexes revealed that, in spite of the volume of catalogued collections, the list of sheets of some series is still far from being complete. The “gaps” in the indexes obviously correspond to gaps in the inventory. On this basis, we added some lines to the list of sheets of some series. These new entries are not documented but they explicitly point to gaps in inventories and thus to the work that is still to be done.

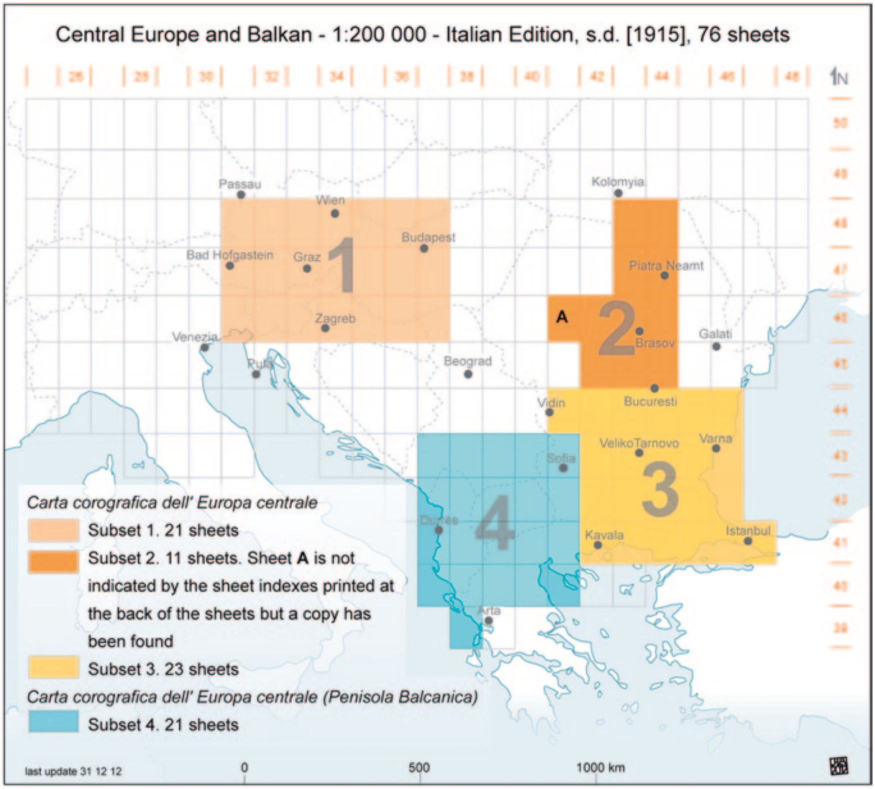

Fig. 3 The four subsets of the Italian edition. For each series, the sheet index completes its definition

5 Identifying the Subsets

Numerous sheets belonging to the original edition published between 1899 and 1918 have a complementary number. This particularity is not rare, for about a quarter of the sheets published during this period carry a double number. In this batch, in addition to the standard number derived from the coordinates of its centre, each sheet also has an order number indicated in bold letters at the bottom right. Although it looks homogeneous, this complementary numbering system does not correspond to a simple list of sheets. Indeed, some sheets that represent the same geographical zone do not have the same complementary numbers. Thus for example, three versions of the sheet *Bolgrad* (46° 46°) each have each a different number: 15, 24 and 181. These correspond to the dates of different editions: 1913, 1914 and 1916. According to this example, the complementary numbers seem to be linked to the chronology of the publication, yet other examples prove this theory to be wrong. The sheet *Odessa* (48° 46°) has the number 183 in 1910 and in 1916, and the number 17 for an intermediary edition of 1913. The copying out of these numbers on a sheet index suggests another hypothesis: each sub-series would correspond to a specific geographic zone.

The sheet index allows the identification of continuities and gaps in the numbering. It also allows the gathering of numbers into homogeneous wholes and, every now and then, the possibility to reconstruct their system of organization. This method has allowed the identification of not less than 11 sub-series of which the layout bears no distinctive sign. In this batch, the perimeter of the most important sub-series corresponds to the perimeter of the original series in its entirety. On the contrary, the ten other sub-series are quite different. Each has only between 10 and 49 sheets, and cover regions in the Eastern two-thirds part of the sheet index, with a predilection for the zone corresponding to the former Yugoslav territory (6 sub-series overlapping). The sheet index of each entity is more explicit than a long description (Fig. 4).

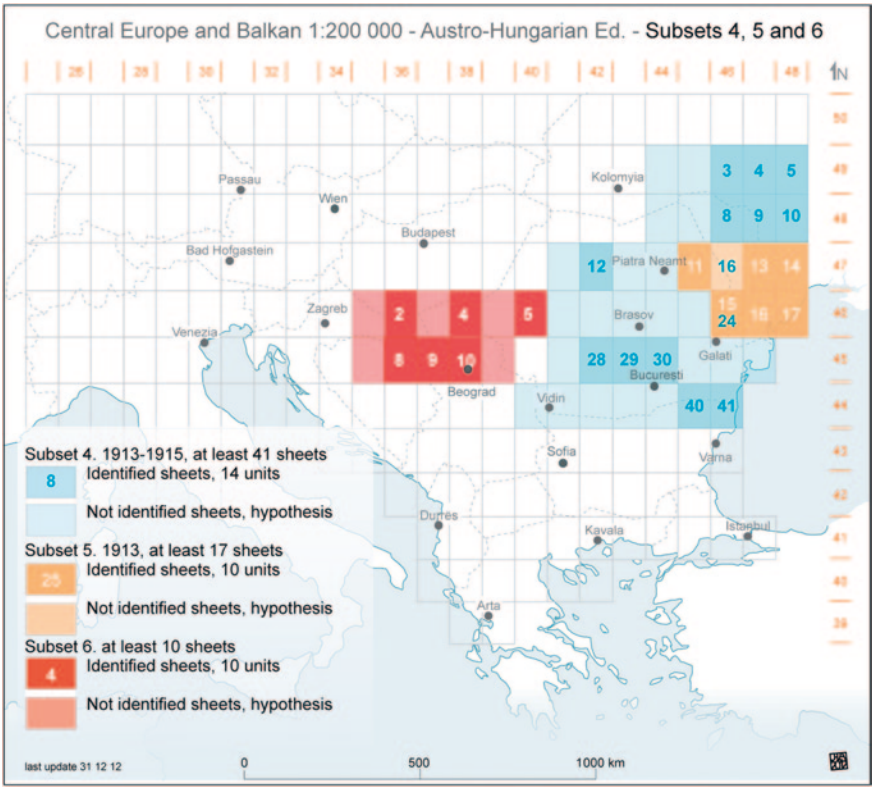

Fig. 4 The subsets of the Austro–Hungarian edition have been identified through a sheet index. It allows to spot the continuities and gaps in the numbering of sheets

5.1 Gathering and Sharing

On the basis of their series title, we divided the sheets bearing the title *Generalkarte von Mitteleuropa 1:200 000*, and those bearing the title *Generalkarte von Miteleuropa Balkan 1:200 000*, into two groups. The copying out of the two corresponding lists on the sheet index indicated that the regions covered by the sheets from these two groups overlapped to such an extent that they could not be considered as independent entities. However, the difference between the two titles does not correspond to a difference in the geographical coverage. In addition, one or the other can be indifferently found for several units. On this basis, all the sheets could be gathered in a single series.

Conversely to this example, the sheets of the French production dating from 1916 to 1919 follow two different layouts. The most numerous are copies with only three colours transcribed word for word from the original edition. The others (9 units only) have no statement referring to the geographical service of the Austro–Hungarian army and the frame of the geographical zone represented is reduced to a simple black line. At the bottom of each sheet, there is a graphic scale in French. On the basis of this difference, the sheets have been divided into two groups. The representation of the geographical area of each group indicates they are complementary. Of the nine geographical units covered by the second series, eight are not represented by those of the first group. The geographical distribution of these units is surprising as they constitute an island inside the first group. The comparison of this peculiarity with the date of publication of the sheets corresponding to these groups in the Austro–Hungarian edition explains this distribution. These geographical units had not yet been covered by the Austro–Hungarian edition at the beginning of the First World War. The French militaries had to find other sources to fill the gaps in their documentation, hence they introduced a new layout to differentiate between the copied sheets and their own production.

6 Defining a Series

The last examples raised the question of the definition of a cartographic series. According to the bibliographical standard, a series corresponds to a set of sheets the publication of which is viewed as a whole. There are at least two aspects to the publication process. First, it corresponds to the stage of production of the documents: documentation, writing and printing. The division of the French production into two groups, as it had been conceived at the end of a first classification, indeed results from an important difference in terms of production. As far as the notion of edition is concerned, it is quite difficult to define when the sheets do not have any proper series title.

The criteria to define a cartographic series can therefore be controversial. The classification of cartographic documents is obviously not an exact science. From the same list of documents, different kinds of clusters can be made. Each is interesting for different reasons, according to the scientific approach. For example, using the organisation of the production method will not give the same classification, the same sharing in series, as an analysis of the relationships between different armies.

At the close of this first stage in our work, the documents listed have been classified in 56 different series. Yet, the eleven groups identified, due to their complementary numbers within the Austro–Hungarian production, could have been added to the list. Regarding the Czechoslovakian series published between 1918 and 1946, the sheets published within the context of collaboration between Vienna and Prague, and those published by the Czechoslovaks only, could also have been divided into groups. Conversely, the entire number of sheets published under the authority of W. Krallert in 1941 could have been gathered together. Indeed, these four groups of sheets form a homogeneous whole, even though they each have a specific title and sheet index.

It is not necessary to increase the number of examples. The list of 56 series as I suggest, can be changed. It is only a first suggestion to provide order. Yet this is not the result of chance, but rather derives from carefully planned work which proves sufficiently operational for each sheet to find its place unambiguously into one and only one group of sheets.

7 List of the Identified Series

1. Austro–Hungarian edition, 1886–1918, 265 sheets
   Covers Central Europe and Balkans, in German
2. Greek Edition, 1909–1941, about 30 sheets
   Covers Greece, in Greek.
3. Austro–Hungarian edition, roads and geodesic landmarks, 1911–1917, 35 sheets
   Thematic map. Roads and geodesic landmarks are overprinted in red on the base of edition 1. In German.
4. Austro–Hungarian edition, aerial, 1914–1915, 14 sheets
   Thematic map. Aerial information is overprinted in red on the base of edition 1. Covers the current border between Austria, Italy and Slovenia. In German.
5. Hungarian edition, 1914–1949, 118 sheets
   Hungary and large surroundings, in Hungarian.
6. Rumanian edition, 1914–1920, about 42 sheets
   Covers Rumania, in Rumanian. Replaced by edition 18 from 1930.
7. Italian edition, *s.d.* [c. 1915], 76 sheets
   Covers Balkans, 4 subsets. In German on the front, in Italian on the back for the key and the sheet indexes.
8. Russian edition, 1915, at least 3 sheets
   Covers current border between Romania and Moldavia, in German, statement of responsibility in Russian.

9. Serbian edition, 1916–1918, 68 sheets
   Covers Serbia, in Serbian, Cyrillic characters.
10. French edition, 1915–1921, 216 sheets
   Covers the eastern three quarters of the original series. Three colors only (no brown). Replaced by edition 19 from 1932.
11. Allied Army of Orient edition, 1918–1920, 42 sheets
   Two groups of sheets: 1. Current Serbia, Macedonia and Bulgaria (33 sheets), 2. Northeastern current Romania (9 sheets). In French.
12. English edition, 1916–1918, at least 16 sheets
   Key east oriented in left margin. In English.
13. Czechoslovakian edition, 1918–1946, 42 sheets
   Covers Czechoslovakia, in Czech.
14. Polish edition, 1919–1922, at least 18 sheets
   Covers a part of current eastern Ukraine. Key in German and Polish.
15. Austrian edition, 1920–1937, about 225 sheets
   In German. Replaces edition 1. Replaced by edition 21 from 1938.
16. Austrian edition, borders, c. 1922, 21 sheets
   Thematic map. Borders, according to Saint-Germain treaty, are overprinted in red on the base of edition 15. In German.
17. Kingdom of Serbians, Croatians and Slovenians edition, from 1920
   In Serbian, Cyrillic characters. Replaces edition 9.
18. Rumanian edition, 1930–1939, about 45 sheets
   Replaces edition 6. In Rumanian.
19. French edition, 1932–1945, 22 sheets
   Replaces edition 10 but smaller perimeter. Covers current parts of Austria, Switzerland, Bavaria and Northern Italy, in French. Each sheet bears : *Europe Centrale 200.000*^{e}
20. German edition, Czechoslovakia, 1937–1938, 33 sheets
   Covers Czechoslovakia, in German. Each sheet bears the title: *Generalkarte der Tschechoslowakei.*
21. German-Austrian edition, 1938–1945, 263 sheets
   Same perimeter than the first edition. Replaces edition 15, published in Vienna. In German.
22. Yugoslavian edition, 1939–1940, at least 23 sheets
   In Serbian, Latin characters. Replaced by edition 45 from 1948.
23. Italian edition, Greece, 1940, at least 12 sheets
   Covers Greece. In blue: longitudes from the meridian of Athens. in Italian.
24. German edition, Greece, 1940–1943, at least 12 sheets
   Covers Southern Greece, in German. Each sheet bears the title: *Mittel- u. Südgriechenland*
25. German edition, 1940–1944, 171 sheets, *Generalkarte v. Mitteleuropa…*
   Covers the Balkans, a part of Central Europe and Aegean sea, in German. Each sheet bears : *Generalkarte v. Mitteleuropa…* Replaced by edition 37 from 1943.
26. German edition, 1940–1944, 8 + 15 sheets, *Generalkarte v. Mitteleuropa..., Zusammendruck*

Derived from edition 25 (large sheets). Covers only the south-east part of the Balkans and Aegean see.

27. German-Austrian edition, administrative map, 1941, about 100 sheets, *Verwaltungskarte der Südoststaaten*
Thematic map. Boundaries of administrative units are overprinted in black on the base of a pale version of edition 21. Published in Vienna. Covers only the central Balkans. Each sheet bears: *Verwaltungskarte der Südoststaaten*
28. German-Austrian edition, demography of north Yugoslavia, 1941, 13 sheets, *Jugoslawien—Deutsche Siedlungsgebiete*
Thematic map. German population data are overprinted in red on the base of a pale version of edition 21. Covers Northern Yougoslavia, in German. Each sheet bears: *Jugoslawien—Deutsche Siedlungsgebiete.*

29–32. German-Austrian editions, ethnical distribution of populations, 1941
Four thematic maps published in Vienna, in German, under the direction of Wilfried Krallert

29. *Volkstumskarte von Slowakei*, 9 sheets
30. *Volkstumskarte von Ungarn*, 23 sheets
31. *Volkstumskarte von Jugoslawien*, 40 sheets
32. *Volkstumskarte von Rumänien*, 44 sheets

33-36. German editions, defenses, about 1941
Thematic maps. Defenses are overprinted in red on the base of the editions 21 or 25. Four series identified for Romania, Yugoslavia, Greece and European Turkey. Each sheet bears the proper title of the corresponding series:

33. *Befestigungskarte Rumanien 1:200 000*, at least 8 sheets
34. *Befestigungskarte Jugoslawien 1:200 000*, at least 25 sheets.
35. *Befestigungskarte Griechenland 1:200 000*, at least 11 sheets, overlap with the edition 36.
36. *Befestigungskarte Türkei 1:200 000*, at least 9 sheets, overlap with the edition 35.
37. German edition, 1943–1945, 180 sheets, *Südost-Europa*
Replaces edition 25. In German. Each sheet bears: *Südost-Europa 1:200 000e.*
38. German edition, 1943–1944, 20 +33 sheets, *Südost-Europa, Zusammendruck*
Derived from edition 37 (large sheets). In German. Covers only the south-east part of the Balkans and Aegean sea.
39. German edition, geodetic reference, about 1943, *Bezugspunktkarte 1:200 000*
Thematic edition overprinted in purple on the edition 37. Each sheet bears: *Bezugspunktkarte 1:200 000*
40. German edition, main roads, 1944, at least 15 sheets
Thematic edition overprinted in purple on the edition 37.
41. German edition, aerial, 1943–1945, approximately 168 sheets
Aerial edition overprinted in red or orange on the base of the editions 25, 37 or 40. Some sheets bears: *Fliegerausgabe*.
42. German edition, aerial, approximately 1944, *Zusammendruck*
Derived from edition 41 (large sheets).
43. German edition, topographical and aerial, 1944, at least 12 sheets, double-sided.
Editions 37 et 40 together.

44. Austrian edition, borders, about 1946, 21 sheets
Thematic edition. Borders of Austria in 1936 overprinted in red on the base of editions 21, 25 or 43. In German. Each sheet bears the statement: *Stand der Grenze 1937* (in red).
45. Yugoslavian edition, 1948–1971, 88 sheets
In Serbian, Latin characters. Replaces edition 22. Longitudes from meridian of Paris. Some sheets bear a new number the (from 1 to 88).
46. Austrian civilian edition, 1936–1948, 26 sheets
Published by *Bundesamt* (or *Amt*) *für Eich—u. vermessungswesen (BEV)*. Original numbering, original longitudes (Ferro). Replaced by edition 47 from 1953.
46a. Austrian civilian edition, basemap, 1936–1948, 26 sheets
Derived from edition 46, printed in washed colors. Published by *BEV.*
47. Austrian civilian edition, 1953–1957, 23 sheets
Replaces edition 46. Published by *BEV*. Each sheet bears*: Berichtigung des Inlandsteiles 195-*. Longitudes from Ferro. Replaced by edition 48 from 1953.
47a. Austrian civilian edition, basemap, 1953–1957, 23 sheets
Derived from edition 47, printed in washed colors. Published by *BEV.*
48. Austrian civilian edition, 1957–1958, 26 sheets
Replaces edition 47. Published by *BEV*. Longitudes from the meridian of Greenwich. New numbering (number of the column and number of the line). Indication of the number in the statement: *ÖM-Blattnummer XX*. Replaced by edition 49 from 1960.
49. Austrian civilian edition, 1960–19–, 23 sheets
Replaces edition 48. Published by *BEV*. Longitudes from Ferro, original numbering.
49a. Austrian civilian edition, basemap, 1960–19–, 23 sheets
Derived from edition 49, printed in washed colors. Published by *BEV.*
50. Austrian civilian edition, 1963–2000, 23 sheets, *Österreichische Karte 1:200 000*
Published by *BEV*. Double statements of longitudes : from Ferro and from the meridian of Greenwich. New numbering : latitude and longitude (from Greenwich). Each sheet bears the title: *Österreichische Karte 1:200 000*
51. Austrian civilian edition, 1960–2000, 23 sheets, *Österreichische Karte 1:200 000 mit Straßenaufdruck*
Thematic map published by *BEV.* Main road overprinted in red on the base of edition 50. On each sheet, the original proper title is completed by the statement: *mit Straßenaufdruck,* in red.
52. Austrian edition, Balkans, 1963–1973, at least 85 sheets, *Generalkarte von Mitteleuropa*
Published by *BEV*. Longitudes from Ferro, original numbering. Each sheet bears the title: *Generalkarte von Mitteleuropa 1:200 000.*
53. Austrian edition, Balkans, roads, c. 1970
Thematic map published by *BEV.* Main road overprinted in red on the base of edition 52. On each sheet, the original proper title is completed by the statement: *mit Straßenaufdruck,* in red.

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Villages, Actors of Local Cartography? The Cadastral Maps of the Banat (1772–1779)

Benjamin Landais

Abstract After the successful work of the military survey of the Banat in 1769–72, the Habsburg monarchy took on an even more demanding task: the systematic division of land into family plots in a huge territory representing an area of almost 28,000 km^2 with approximately half a million inhabitants. The cartographers found themselves in a new position vis-à-vis the rural society and had to face the institutions of the village communities. The surveying and mapping of the land was indeed tied with a new mission: imposing on the farmers the geometric and final definition of their plots. The few cadastral maps that have been preserved in Vienna and in Budapest can be studied as the result of a complex social process involving peasant-farmers, local worthies, rural communities and cartographers over a rather long period of time. The different actors usually made arrangements between themselves, although mutual misunderstandings and conflicts occurred too. The current—and almost classical—approach to the cadastral and estates maps, whether ordered by States or private landowners, provide an interesting analytical framework. They point out the influence of the rationalising tendencies of the estates' management and the tax system in the early modern period on this type of mapping and describe maps as a form of communication. But identifying signs of peasants' and villages' participation in creating the maps is more difficult than understanding the logic of power. Fortunately, the possibility of combining an analysis of iconographic sources and of the detailed reports about the local activity of the cartographers-engineers in Banat, allows overcoming this difficulty.

1 Analysing Cadastral and Estate Maps

Are villages and peasants real actors of cartography? The answer to this question seems to be quite obvious. It must be "no", insofar as only the work of the engineer-cartographer and land surveyor matters. It still must be "no" if

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considering the circumstances and external factors that can explain the production of these cadastral maps: the concerns of the Habsburg administration of the Banat as representative of the land-owner—because this region was considered as the land property of the Emperor—and the desire to implement fiscal reforms are clearly determining. But the answer must be "yes" if considering maps as graphic expressions of the division, the demarcation and the distribution of lands and plots performed in every village by the representatives of the administration, the so-called "Ingenieurs", but also by peasants and representatives of the villages' political institutions.

Despite their abundance among the handwritten maps, estate maps and cadastral maps of the early modern period, especially those from the eighteenth century, have been studied only rarely in the history of cartography. One of the reasons for this lack of research is probably that this type of map does not demonstrate a special proficiency on the part of the cartographers. In his book of 1996, the historian David Buisseret explains the particular difficulties of this task:

> Among cartographic types, the estate map occupies a rather peculiar place. It is possible, even if not desirable, to study most other types of map without reference to the social and economic system out of which they emerged. […] Such a divorce between the map and its society is impossible in the case of estate maps, which insistently pose the problem. What social and economic circumstances gave rise to this map? It may well be for this reason that they have never been systematically studied, for it is difficult to relate cartographic and socioeconomic developments in a wide variety of countries (Buisseret 1996: 1).

Several methods were considered to examine the specificity of these cartographic productions. Many authors (Williams 1984; Harley 1988; Bendall 1992; Buisseret 1996; Kain and Baigent 1992 and 2007) concentrated on the reconstruction of the social and cultural context in which these maps were drawn and used. The first question asked by these studies concerns the reason for the existence of one particular type of map at a specific place and at a specific time. The social structure, the way the landowners managed their estates, and the tax levy system were usually mentioned as the most important explanations. In these reconstructed contexts, these large-scale handwritten maps were considered as appropriate tools of government and management. The difference between the maps ordered by the State and by private landowners is not always very clear in this period. The historical context, in particular the traditions of recording the peasant properties, can be more important than the distinction between the State power and big estates.

Hungarian historiography, on the other hand, is very rich on this issue. For more than a century many studies of rural history, demographic history and ethnography used the large-scale handwritten maps of the eighteenth century available in the national and county archives. The 1:28,000 scale maps produced during the Austrian military survey under the Empress Maria-Theresa, as well as the numerous cadastral and agricultural maps drawn in the second half of the eighteenth, were mainly used as secondary sources and as illustrations. Furthermore, historians of mapping were also interested in this type of maps. The result of those works concerned the so-called 'urbarial' maps (úrbéri térképek). This name refers to the 'urbarial' reform of 1767, that is, the regulation of the rights and benefits that the estate holder had over his peasants. Hungarian historians have shown that this type of map was not drawn systematically, although new registers mentioning the rights and the size of the plots of every serf were established in every village. The general making of those maps—similar to cadastral maps—was only ordered and produced by counties after 1844 (Fodor 1957; Plihál 1983). Counties' administrations considered it as one of the means to achieve the progressive emancipation of the serfs and to control this process. The few 'urbarial' maps that are to be found in the archives before this time were used for another purpose. They were produced in particular circumstances—for the inventory and rationalization of the management of the royal estates (for example Obuda, arad-modenai uradalom…) or in order to prepare the colonization of the land in the southern part of the kingdom (Bácska). These maps registered the individual plots of farmers but were considered as instruments for estate management, rather than as a legal guarantees for the rights of owners.

The concerns, intentions and uses of estate maps by landowners or their representatives are well known today. The origins, education and the nature of the work of the engineers-cartographers have also been studied (Fodor 1952; Raum and Joó 1992 and 1993). However, an important dimension of the social role of the mapping remains largely unknown: the place and participation of the farmers and the political village's institutions in the maps' production process. Before getting into specifics, one important distinction must be made: dividing the lands and surveying on one hand and mapping the village's lands on the other hand. Not surprisingly, the first activity supposes a direct collaboration or—eventually—a direct conflict between the engineer and the farmers. It is not necessarily the case for the second one. But can mapping, in this context, be thought of as a process that is totally cut off from the interaction with rural society and as a mere final recording of the results of the division and surveying of the land? Is it possible to know the role of these maps using other documents written by local institutions? How can these maps be read in the light of this new approach?

2 Dividing the Land, Surveying and Mapping

2.1 The Mapping Tradition and Culture of the Engineers-Cartographers of the Banat

The imperial armies conquered the Banat in 1716 and the region officially became part of the Habsburg monarchy after the peace treaty of Passarowitz (Пожаревац in Serbia) 2 years later. At that time, maps had already been used as tools of government by the Habsburg administrators since the beginning of the 16th century (Buisseret 1992: 4, 5; Kagan and Schmidt 2007: 662; Török 2007). Military cartographers played the most active role in this area. The mapping of Banat, Bácska and Austrian Serbia served military objectives. It facilitated the control of the territory and the organization of its defence by choosing the best strategic places to install forts and fortresses. With this aim in mind, from January 1717, Prince Eugene of Savoy asked General Florimond Claude, Comte de Mercy d'Argenteau, the military governor of the Banat, to make maps of the Danube.

Despite the first efforts of the military cartographers to map the strongholds in the Banat, the land outside the city of Temesvár (Timişoara in Romania) and the towns of Becskerek (Зрењанин in Serbia) and Pancsova (Панчево in Serbia) in the West Lippa, Lugos, Karánsebes and Orsova (Lipova, Lugoj, Caransebeş and Orşova in Romania) near the Transylvanian borders, was little known. A considerable mapping effort was still necessary. The first tax census, under the form of a list including all villages and the number of inhabited houses, was undertaken in 1717. But the administration had to wait several years to be able to locate each village on a general map. Between 1718 and 1725, 1:122,000 scale maps of every district were produced by the military administration (OeStA, FHKA, B IX a 554). They depicted woods and forests, hills, mountains, main roads and rivers, swamps and the position of villages but included no indication about the agricultural use of the lands. In 1725 a general 1:255,000 scale map of the whole province was made by the engineers Haring, Kaiser and Hautemont vom Neiperg Regi. Numerous copies of this work are still available in archives and libraries in Austria and Hungary (Patay 1979).

The golden age of the administrative mapping in the Banat only began after the Austrian-Ottoman wars of 1737–39. In contrast with the first half of the century, 'military purposes were not usually at the centre of these mapping projects. Nevertheless, the meticulous mapping of the Ottoman borders in the middle of the century (MOL, S11 N° 715/I: 1–24) and of the fortifications of Temesvár (OeStA, FHKA, Kartensammnlung, O-098, O-099, O-107, O-110, O-114 and O-130) have to be mentioned. From 1750, the civil administration regularly ordered maps from its two full-time engineer-cartographers. Contrary to the previously-mentioned military maps, the civil ones were not general maps of the province, a district or even a village until 1770. The activity of the engineers was closely connected with the activity of the civil administration's construction staff and the mining district. That is why the cartographic production was dedicated to mining buildings as from the 1740s, bridges and catholic churches as from the 1750s, and schools and presbyteries as from the 1760s and early 1770s. More rarely, these two engineers drew larger scale maps in relation to colonization, improvements in agriculture and the drainage of swamps. This type of map was, however, always very simple and only showed the few elements that were necessary to undertake the planned works.

An important change took place at the end of the 1760s. Before that, civil maps used to be considered as annexes facilitating different types of construction projects but, contrary to the military maps, not as tools of government. To serve the new reforms initiated by the regional administration, new general maps had to be drawn. A map of Banat representing all the villages—and distinguishing between new colonies and older villages—showing swamps, roads, canals and the limits of the district was produced in 1765 (OeStA, FHKA, B IX a 564). An update of the first map of 1725 was indeed necessary after the important demographic changes which occurred as a consequence of massive colonization. In 1770 a set of district maps was produced (OeStA, FHKA, Kartensammlung, A-066 to A-071). The administrative reorganization of the province in 1775, with the creation of circles modelled on the Moravian example, and the creation of counties in 1778 (MOL, S11, N° 245, 249 and 251), required new maps showing the limits of these new entities.

There is a second factor which also explains this important change in the use of maps in the Banat. The Austrian military survey took place in this region between 1769 and 1773. Based on Maria-Theresa's decree of May 13th, 1764, the survey took a particular form and content in the Banat. Although this project was a purely military initiative, the demands of the civil administration had to be taken into account by the military cartographers. Indeed, the empress tried to reconcile the concerns of Vienna's court Chamber and of the military court council that both manage the Banatean affairs. The systematic mapping of the Banat began on May 10th, 1769 under the direction of Baron Philip von Elmpt with 33 military engineers divided into three teams. Rivers, roads, villages, isolated houses, woods, swamps, mountains, hills and the most important characteristics of soils are represented on these 1:28,800 scale maps. Following the civil administration's demands, a list of data sometimes appears on the right-hand side of a map. This list includes the names of the villages visible on the map information which is always shown) the indication of the language spoken by their inhabitants (Serbian, Wallachian or German) and, more rarely, the number of houses and individual plots. This operation ended in 1773. By that time, 208 large-scale maps and a six-piece general map of the Banat had been drawn (OeStA, FHKA, B IX. A. 577). As impressive as they may seem, these maps are still far from being cadastral or even agricultural maps and were useless for any possible civil construction, colonization or tax reform projects.

Nevertheless, this first experience of massive local mapping in the Banat was essential for the further development of regional cartography. Many military engineers, first of all their director Baron Philipp von Elmpt, stayed in the province after this work. Nine civil engineers and twenty-nine military engineers were brought together in a new 'Mapping corps' and were at the regional administration's service, without distinction based on their institutional origins. As well as producing a few maps for the construction and the fortification staff, this corps was since 1773 in charge of the cadastral mapping of the province. The role of these engineers-cartographers was thus completely changed. The maps they produced had a legal status and were not just tools of local government. Moreover, in relation to the rural population, they acquired a prominent social position as land surveyors responsible for the legal division and repartition of individual plots. They became legal representatives of the Emperor, considered as lord, landowner and sovereign in the Banat. From a social perspective (Landais 2012), rather than from the point of view of the cartographic technique, this represented a new experience for these employees.

2.2 Aims and Elaboration of the Cadastral Reform

The division of lands and the introduction of individual plots for peasant families were introduced in Banat only 2 years after the so-called ‘urbarial’ reform in the kingdom of Hungary. Although several aspects of the two reforms seem to be similar—in particular the standardization of the size of allotments, the legal definition of the rights and obligations of the serfs towards their lord and the systematic census of the peasant families in the villages—the Banatean reform represents a more important turning point for the villages’ institutions. Before this time, there was not any ‘Urbarium’ between the administration, which represented the landowner, and the peasants’ communities in the Banat, whereas this type of contract or register can be found in the kingdom of Hungary. This reform did not only introduce the principle of State regulation for the ‘Urbaria’, but the ‘Urbaria’ themselves. The historical contexts that could explain the occurrence of the two reforms are also different. In Hungary, the reform was introduced by Maria-Theresia after a powerful peasant revolt in Transdanubia in 1765 which aimed to reduce the power of the estates’ owners. In the Banat, the idea of reform arose after a complete renewal of the administration’s employees and a change of mind within the State Council regarding the opportunity to introduce a land-tax system in the province. In retrospect, this can be considered a top-down initiative.

The reform was based on the introduction of family property and a land-tax system. Every family that wanted to receive land to cultivate and/or to feed its cattle, had to get one allotment divided into six plots (three fields for agriculture, one meadow to make hay, one plot or a house and a backyard and one pasture land plot which was often integrated into the village’s common pasture land). These six plots constituted a ‘session’ (about 34 ha.), half a session (19 ha.), a quarter of a session (6.3 ha.) or even the eighth part of a session (3.4 ha.). A session or part of a session was indivisible and could only be handed down in the family. No one could receive more than one *session*.

	Complete *session*		1/2 *session*		1/4 *session*		1/8 *session*	
	Jugerum (Joch)	*ha*	Jugerum (Joch)	*ha*	Jugerum (Joch)	*ha*	Jugerum (Joch)	*ha*
Fields (Ackerfeld)	24	*13.8*	12	*6.9*	6	*3.5*	3	*1.7*
Meadows (Wiesen)	6	*3.5*	4	*2.3*	2	*1.2*	1	*0.58*
Pasture land (Huthweide)	3	*1.7*	2	*1.2*	1	*0.58*	1	*0.58*
Land for house and yard (Hausgrund)	1	*0.58*	1	*0.58*	1	*0.58*	1	*0.58*
Total (Summa)	**34**	***19.6***	**19**	***11***	**11**	***6.3***	**6**	***3.4***

Together, these *sessions* constituted the so-called *Constitutiv-Grund*. Peasant families and village communities had to pay the newly created land-taxes for these allotments. Other lands were considered as supernumerary lands (*Überland*) and could be arbitrarily distributed to other villages or to settlers coming from the

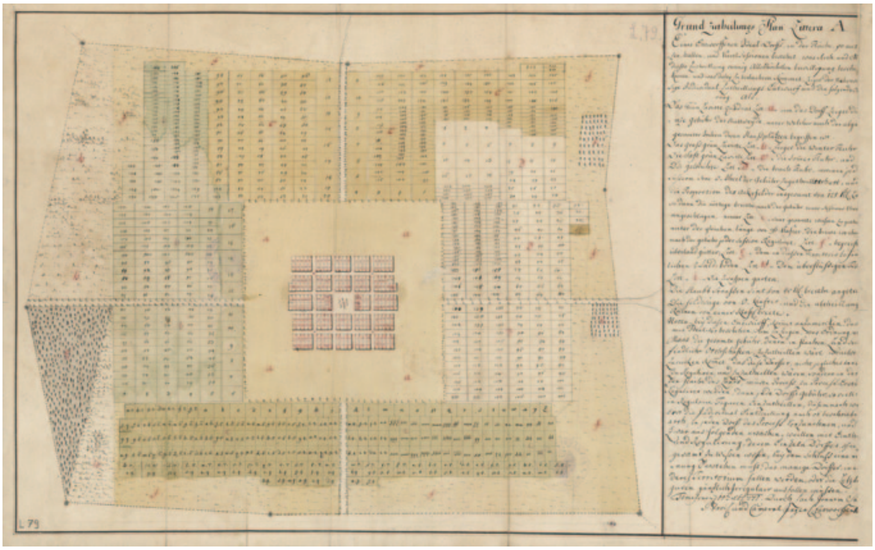

Fig. 1 Map of the 'ideal village', 1771 (*Courtesy* of OeStA, Vienna) [OeStA, FHKA, Kartensammlung, L079]

Ottoman Empire, the Holy German Empire or the kingdom of Hungary. If these plots remained free of occupation, they could be rented out to families who agreed to pay the annual fee, or to the whole village community, especially the forests and swamps. However, these families could never be considered as owners of these plots and had to be content with their *sessions*. The Viennese administrators who devised this reform aimed to make the peasant a good taxpayer and a small landowner who should be concerned with providing for his own prosperity. They wished to encourage the famers' efforts to increase their cereal production and to constantly improve their lands (Fig. 1).

All the principles of this reform can already be seen in those that underpin the creation of an ideal village, designed by the civil engineer Johann Sax in December 1771 (OeStA, FHKA, Kartensammlung, L 079). A census of the same ideal village, without farmers' names, was also written up at the same time. This document was designed for internal use within the small group of regional administrators working in Temesvár. The organisation of village lands and the nature of different areas according to the new tax-system were very clear. Houses with private yards coloured in white and red are in the centre of the map. The beige area surrounding this square represents the common pasture land for the cattle. Beyond this zone, four areas divided into plots of different sizes are shown. Three field zones corresponding to the lands cultivated according to the crop rotation system (one zone for the summer crop, another for the winter crop and the last one as fallow) and a meadow for gathering hay can be seen. In every zone, we can count the same number of plots of identical size. Finally, in the margin, the so-called

Überland is represented, as well as little plots of land for a wood, a vineyard and an orchard. Unsurprisingly, the orthogonal characteristic of the road network inside the village and of the division of the main agricultural zones is typical of the German colony constructed at the same time in the Banat and in the Bácska. During the previous decade, the administrator responsible for this reform and the civil engineers who participated in the conception of the reform, were used to preparing grounds and plans for this type of village, rather than to improve the organisation of the fields and the streets in the older villages. The orthogonal appearance of this ideal map also reveals the intention of the administrators to take advantage of the cadastral reform to promote the geometrical order in the demarcation of plots and the reorganisation of the inhabited space.

2.3 The Central Role of the Engineers in the Implementation of the Reform

The creation of a land register for every village of the region was the main objective of this reform. From the outset, administrators aimed to give a textual and a visual expression, i.e. a cadastral map, of this land register. From the beginning, engineers were supposed to be land surveyors and cartographers at the same time. To this effect, Wolfgang von Kempelen, the royal commissioner responsible for the conception of the new tax and property system, sent an instruction to the Baron Philipp von Elmpt, director of the mapping corps as from November, 1769 (OeStA, FHKA, Ungarn und Nebenländer, Hs. 469, f° 60–65). This project was, however, very ambitious as it did not take the difficulty of the task into account. The Banat represented more than 600 villages, 400,000 inhabitants, and almost 28,000 km^2 and suffered from a total lack of tradition as regards the regular division of land. The mapping of this area would not be that easy.

The concrete implementation of the reform, beginning during the autumn of 1772, proved to be more difficult than the mapping of an ideal village. The announcement of the introduction of the new tax and property system based on the systematic division of the lands took place in September 1772. According to the general instruction of the administration president, Clary von Aldringen, every district governor had to explain the new system to the assembly of village chiefs (called ‘knezes’ for the Orthodox villages and ‘judges’ for the Catholic ones) which, every month, gathered in the district’s administrative centre in order to bring taxes to the local authority (*Amts-Tag*). After this first step, each district had to organize a ‘local direction’ to implement the reform in every village. The work of these ‘local directions’ was three-fold:

1. The explanation of the reform to the village assembly, that is the gathering of all the family chiefs (the adult male population and a few widows), and the census of all the houses and the families of the village. Every family had to declare the size of the ‘session’ it required.

2. The surveying and the division of the village lands into different zones. The size of the zones had to correspond to the sum of the ‘sessions’ declared by the families during the first phase.
3. The division of the ‘*Constitutiv lands*’—except the common pasture land—into individual plots and their distribution to the families.

The ‘local directions’ were composed of the district governor and the vice-governor, one military officer, some secretaries, several engineers and the representatives of village communities, i.e. the so-called ‘Ober-knezes’ which were local worthies elected every 3 years by a group of villages. The engineer was not at the top of this hierarchy, but his role was fundamental. Regarding the concrete operations on the ground, the engineer played a leading role. Together with the knez and at least six village elders, he was responsible for the fair census of the taxpayers and of determining how much land every family needed. If necessary, the engineer was allowed to transfer land from one village to another. In certain cases, he could even require some inhabitants to leave their village and to settle in a place where more land was available. With this in mind, the power of the engineer as a land surveyor at the service of the administration was, at least theoretically, considerable. In fact, it was limited by the protests and, above all, the social inertia of the village communities which was a means to express their reluctance to submit to the new system. A certain disappointment on the part of the administrators emerged from the first experiments. The noticeable enthusiasm and optimism of the small group of administrators responsible for the whole conception of the reform had disappeared during the winter 1772–73. The willingness of the farmers to obtain the ownership rights on plots was moderate. Entire villages blamed the new fiscal system for the important rise in taxes which were in some cases quadrupled. Efforts to divide the lands and to distribute plots were often reduced to nought in the days after the land survey had been completed. The result was that the peasants returned to the former situation and ignored the division made by the engineers. Some knezes justified their refusal to accept the new land division because of the excessively small space left for the pasture lands in comparison to the crop fields (MOL, E304, 5 cs., f° 504 and following, 18/10/1773). This situation made it necessary to organise a new survey of lands and to find a new method to impose the reform. Two different ways were chosen. Firstly, punishments against those who did not accept the new system were made harsher. But, secondly, the president of the regional administration recommended that the village communities should divide their lands themselves, once they have accepted the principles of the reform. In this context, the engineers did not have to impose their will against the farmers but to control and to guide an operation actually led by the local worthies. Despite this measure, conflicts between the engineer and the inhabitants were still possible.

Other difficulties arose concerning the mapping activity of the engineers. The terrain could make it harder to represent a village’s lands and family plots. That is why mountains were the last zone to be mapped. As could be expected.

Baron Philipp von Elmpt questioned whether it would be possible to complete the mapping of the whole province in a relatively short time. In March 1773, he estimated that it would take 9–10 years to complete the projected work. On July 1st, 1773, after his third journey to the Banat, Joseph II himself expressed his scepticism about the utility and the efficiency of the division of lands (OeStA, FHKA, BA, Nr. 212, f° 761–765, 1/7/1773). He even wondered if the slowness of the mapping did not call the whole reform into question. His letter confirmed the fact that the making of cadastral maps in association with a land register in the form of a list was still far from being natural and not considered necessary, even though he was long-standing supporter of the idea that a land tax-system and the private ownership of family plots were important factors contributing to the modernisation of rural society. However, although cadastral maps were not considered necessary, and although the administrators were rather used to reading estate and military maps to guide their decisions, this former type of maps continued to be produced in the Banat.

3 Reading the Cadastral Map

Many factors probably contributed to the continued production of cadastral maps in the Banat despite the difficulties of rapidly finding a normal use for this type of document. The desire of the engineer-cartographers to keep their jobs certainly played an important role. They could sometimes justify their salary by the profit made by the administration thanks to the new land survey because it allowed raising taxes (MOL, E46, 25 cs., 42 kf.). However, it is impossible to reduce the development of the local mapping in the Banat to a simple professional concern. Cadastral mapping in the Banat met a social need involving more than just the engineers and their paymasters.

The use and the ways to construct the cadastral maps remained uncertain during the first months, not to say the first years of the reform implementation. Contrary to the elaboration of the land register and to the land survey, there were few efforts to standardize the production of maps. This perception is reinforced by reading the surviving maps. Every map includes the same elements as the cadastral maps of the ideal villages already mentioned: a presentation of the different agricultural zones, the limits of the individual plot and the numbering of each plot. These three elements are necessary to recognize this type of map. However, many variations exist. Colours and figures can vary between two maps representing the same area. More importantly, cartographers did not make the same use of family names and geographic markers on the maps.

Unfortunately, few cadastral maps of this period are preserved in the national archives of Vienna and Budapest. However, certain documents are in fact copies made in the 1780s or the 1790s in Temesvár. The reports of the ‘local directions’ systematically mention the existence of maps for each village but it is difficult to determine whether all the original documents were of the same quality as the maps that can still be found today. Nevertheless, the combination of the analysis of this little collection of maps and the documents produced by the ‘local directions’ for the division of lands, allow us an examination of the way the cadastral maps were progressively produced, corrected and used.

3.1 Gradual Stabilisation of the Social Use of the Cadastral Map

In addition to the technical difficulties of surveying and the mapping, the engineers had to face—sometimes alone—the village communities. The engineer was often the only man responsible in the field for the division and the measurement of ground according to the principles of the reform. The success of his activity depended on the goodwill of the village worthies: knezes, i.e. orthodox priests, elders, councillors. In certain cases, he was the target of the inhabitants' hostility. Cases of physical violence against the engineers were rare. Refusals to cooperate were more frequent. To remedy this problem, certain district governors did not hesitate to send a detachment of cavalry to protect the activity of the engineer. What was more common, was that the families or village communities who thought their rights had been encroached on, would send petitions to the 'local directions'. These institutions were indeed expected to rule on the disputes over the new distribution of land. The goal of these demands was obviously to change the result of the surveying activity of the engineer. They referred to the size and the geographical position of the contested lands in the form of a list or a short description, but rarely mentioned the existence of cadastral maps. The engineer was considered as the land surveyor by the famers and as a surveyor and a cartographer for the administration, because all the maps that were produced on the field were directly sent—even if not finished—to the 'local directions'.

Systematic reports, cadastral maps, summary tables of the measurements of the villages' grounds and results of the census are the four types of documents which were produced by an engineer for each village. The first document was destined for the administration. It could justify the activities of the engineers and point out the problems that remained to be solved. The last two documents were used by the district administration but were also familiar to the local worthies as they constituted a base to define the level of the tax. The second one, the cadastral map, played a more complex role as it was kept at the district governor office. Nevertheless, this type of document was frequently used to resolve conflicts with farmers. For example, in Caransebes in 1774, a violent conflict occurred between the Orthodox and the Catholic communities over the distribution of the land. The Orthodox part of this big village contested the right of the few Catholic farmers and craftsmen to occupy a portion of the lands and, as a consequence, the way the engineer had distributed the plots (MOL, E304, 8 cs., f°176r–192r, 24/7/1774). The district governor explicitly mentioned the map drawn by this engineer in his report. Due to the widespread disagreement, this map was not considered as definitive but just as a project that had to be corrected. The solutions proposed by the governor were all based on the reading of this map. A similar case occurred in 1775 in the district of Temesvár. After a complaint of the butcher of St Andrasch about his plots, the governor dealt with the case by suggesting some changes on the engineer's unfinished map (MOL, E304, 9 cs., 19/01/1775). In this context, cadastral maps were used as tools for management from afar.

The way in which the map went back and forth between the ‘local directions’ and the engineers shows that its use was rather complex. The engineer was not as powerful as he seemed to be during the process of dividing and surveying the lands. The cadastral map he had to draw was not only a guarantee for the preservation of the land division against possible encroachments by unsatisfied farmers or villages—that is to say, a tool of social control over the rural society. It could also be considered as a guarantee for the progressive and negotiated elaboration of the division of land. Important decisions were made by the ‘local directions’ and not by the engineers. Strictly speaking, villages did not participate in the elaboration of the cadastral maps but could indirectly influence its modification with their demands. Only if they directed their complaint directly at the district centre to be served in front of an administrative secretary and the governor, could the deputies of a dissatisfied village challenge the decisions of an engineer on the basis of the map he had produced. This was the case for the village of Engelsbrunn (today Fântânele in Romania), a recently founded ‘German’ colony, that succeeded in accessing its cadastral map (MOL, E304, 11 cs., f° 348r–349v, 1775). However, this possibility could only be used as a last resort. Once the map had reached the governor’s desk, there was not much time before the authorities made a final decision on the land division.

The process of creating a cadastral map is visible on the unfinished map of Perlasvarosch (today Перлез in Serbia) of 1772 (OeStA, FHKA, Kartensammlung, O-135). It is the first example of a Banatean cadastral map preserved in the public archives. The presence of this map in the Austrian national archives can be explained by presenting the particular situation of this locality. The name of this village refers to the president of the regional administration, Don Francesco de Paula Ramon, Count Vilana Perlas, who was active between 1753 and 1768. In order to develop commerce between the Banat and the Adriatic coast, the administration decided to found a commercial company and a port on the Tisza to export local products towards Fiume. As a consequence, Perlasvarosch was founded in 1762 on the site of the former village of Szighe, whose inhabitants had been evicted the previous year. Because the company went bankrupt, the port had to be let to another company. The cadastral map and the attached land register could be used to estimate the value of the village and thereby determine the price of the rent. Despite this specific situation, the processes of surveying and mapping the land did not seem to differ from that of the rest of the region (Fig. 2).

The borders of the village’s lands are shown in dotted lines. This type of limit, called ‘*Hottar*’, from the Hungarian word ‘határ’, was already recognized by the regional administration before the cadastral reform. That is why it constitutes the original framework of the map. But it is not the case for the internal limits of the village’s lands. The geometric delimitation of crop fields (N° 1–3), divided into three areas and myriad plots, the common pasture land (N° 8) and the meadows (N° 4) were a result of the engineer’s work completed during the implementation of the reforms. The inhabitants of Perlasvarosch accepted to use these areas and to pay a land tax for them. Beyond this first area, the rest of the map is almost empty. The free grounds, in the western part of the map (N° 9), could be let to

Fig. 2 Map of Perlasvarosch, 1773 (*Courtesy* of OeStA, Vienna) [OeStA, FHKA, Kartensammlung, O-135]

local farmers or reserved to new inhabitants. Moreover, the two big empty zones in the eastern part (N° 11 and N° 12) were not reserved to the peoples of Perlasvarosch and were going to be definitively removed from their lands. The engineer satisfied himself with the drawing of the limits of the '*Constitutiv Grund*'. However, the decision to alienate one or more piece of a village's land and, as a consequence, redefine the borders between villages, was not his responsibility. It was up to the 'local direction' to take this decision and then decide whether to complete the first map.

The definitive version of this cadastral map is unfortunately not available in the archives, but it is possible to have a precise idea of its form. The plan of Nemeschest (today Nemeşeşti, in Romania), a small village located in the mountains, is one of the rare original cadastral maps of the Banat still available (MOL, S11, 746). Drawn by a certain Pierker, this map also includes a table with the surface area of the different zones and a representation of the orchards owned by the inhabitants. Because of its mountainous location, this village was one of the last to be surveyed and mapped. The division of lands occurred in October, 1777, 5 years after the beginning of the reform's implementation. Two elements distinguish this map from the previous one: on the one hand, the lack of empty zones inside the village's territory reflects the fact there did not remain any doubt about the use of the land. On the other hand, an official inscription can be read in the bottom left-hand corner. It confirms the acceptation of the division of lands in this village by the 'local directions'. With this last inscription signed by those who constituted this 'local direction'—a military officer, a governor and a vice-governor of district—the map became a legal document. The time for negotiations had elapsed. The size and the situation of the plots of the 17 landowners whose names were written on the map were definitively defined (Fig. 3).

Fig. 3 Map of Nemeschest, 1777 (*Courtesy* of MOL, Budapest) [MOL, S11, 746]

3.2 The Cadastral Map as Palimpsest

Due to the change in the villages' lands, the arrival of new inhabitants and land reclamation from the swamps or flood plains, the cadastral maps became rapidly obsolete. The revision of villages' surveys and maps required continuous work on the part of the local engineer-cartographers. This kind of survey was called 'Reambulation' or 'Reambulierung', a type of work which different from the first division of lands imposed between 1772 and 1779. Engineers did not have to create a new geometric order and to make villagers accept the principle of the land tax system. For this reason, original maps could be used and corrected. However, the changes made in the first years seemed to be so important and so frequent that the first maps could no longer be used because of their poor condition. This is one of the reasons why the majority of cadastral maps of the Banat preserved in public archives was not drawn in the 1770s but is constituted of copies made between the 1780s and the 1810s.

The cadastral map of Ujpécs (today Peciu Nou in Romania) is a case in point. As with many other maps of this period, this document has the appearance of a palimpsest (OeStA, FHKA, Kartensammlung, L 020). According to the texts present in various places, it is a copy made in 1784 of a cadastral map of 1774. The name and the quality of the man responsible for the 'local direction' (the hauptmann von Specht and the district governor Johann Georg Walbrun) of that time are mentioned. The first 'Reambulation', already made in 1782, is mentioned in the table in the bottom right-hand corner. This can explain why the first map of 1774 was already considered as obsolete 10 years later. Two more general ‘Reambulations’ are mentioned on the map in 1786 and 1790–91. Then, only two partial revisions were made before the end of the century: the first one in 1795 for seven plots and the second one in 1797 for two plots. After a first period in which the extent of the changes made on the map was still significant, they became more moderate. In that way, it was possible for this second map to be used for about 15 years and to survive two major and two minor revisions, although the original one was already considered obsolete 10 years after it had been drawn.

The lifetime of a cadastral map as a material document was not very long but could be considered as much longer if we take into account the fact that the first model could be reproduced for several decades. The possibility not to alter the first cadastral map was made all the easier if the plots had been scrupulously numbered. Contrary to the map of Nemeschest, the change of a land-owner did not require rewriting the name on the map. Only the so-called ‘book of lands’ had to be updated. Moreover, the legal interdiction to redefine the borders of the plots left the majority of the map unchanged. The revisions only concerned the margins of the villages’ lands, the so-called ‘Überlander’ and the land of poor quality. The engineers could draw new plots in these zones and noted the change of nature of these lands by writing a short description inside the zones or in the margins of the map.

The necessity to redraw a map depended on the local situation. Ujpécs, a German colony installed on the Western plain of the Banat since 1724, was quite easy to map. Moreover, the very few supernumerary lands left few possibilities to install new inhabitants. However, in other cases, the lifetime of a cadastral map could be shorter. For instance, the map of Zombor (today Szombor in Hungary) is very similar to the previous one. It is a copy made in 1783 of a cadastral map first drawn in 1775. The civil engineer responsible for the revision of the land survey, Leopold Uberty, had already been active during the cadastral reform 10 years earlier. However, because of the particular geographical situation of the village, in the middle of swamps, the first ‘Reambulation’ of 1782 required a new map, unlike Ujpécs. The changes caused by the progressive draining of the swamps and the results of the disagreements over the ownership of three islands in the Maros River, located on the border between the Banat and Csongrád County (MOL, E46, 22 cs., f° 1–14), were too big to be represented on the first cadastral map (MOL, S11, 646:1). Due to the presence of swamps and flood lands, the different agricultural zones were particularly entangled. The crop lands, vineyards, fields of hemp (*Kender Földeck*) and of tobacco were located close to the village. The less fertile lands were situated a bit further away. Changes to the limits and of landowners were more frequent in this part of the village’s lands. It was mainly occupied by vast plots of land (up to 10–15 ha.) surrounded by swamps. Considered a few years before as supernumerary lands, they had been very recently integrated into the peasant lands. They were marked with the last numbers (110–120) and, sometimes, with their landowner’s name. These new lands are also mentioned as ‘gained land’ in the table situated in the margins of the map. It means that the ‘Constitutiv Grund’, that is to say the land for which inhabitants had to pay land taxes, had grown by 150 ha. In this case, the new mapping was tightly connected with the wish to prevent the free use of the land (Fig. 4).

Fig. 4 Map of Szombor, 1783 (*Courtesy* of MOL, Budapest) [MOL, S11, 646:1]

3.3 Geographic Markers: Peasant Memory and Administrative Control

One last problem concerns the connection between land surveying and the relation with farmers and villages on one hand, and the mapping on the other: the reliability of the geographic markers chosen by the cartographers. Because of the lack of natural markers such as hills, trees or permanent streams on the Western plain, the engineers had to choose other types of markers in order to ensure that the map could be used as a legal guarantee for the villages' land, agricultural zones and individual plot limits. There was no attempt to standardize these markers. In most cases, the borders of a village's land were marked by mounds (*Hügel* in German, *Halom* in Hungarian, *Gomila* in Serbian), the name of which corresponded with the name of an inhabitant of the village in question, or of the neighbouring one. This inhabitant was the legal proof of the precise location of a particular marker. Sometimes, it was not a mound, but a 'tanya' or 'Salasch', that is to say an isolated house, that served as geographic marker. To avoid possible confusion between markers, each name appears only once on a map. At first sight, this method seems not to guarantee the durability and the reliability of the markers. A farmer responsible for a marker may indeed find it advantageous to move a mound. In fact, this method is not based on the trust in isolated famers or in one particular village community. On the map of Újpécs and Zombor, we can actually see a succession of German, Wallachian and Serbian names on the first one and Hungarian and Serbian names on the second one along the villages' limits. It means that the engineer or the 'local direction' alternatively appointed, or maybe recognized, members of the two neighbouring villages responsible for a limit's marker. They are probably councillors or worthies: for instance, the family Mustez, mentioned twice on the southern limit of Újpécs, were known in the region as big cattle merchants living in Cebza, a village located between Ciacova aud Peciu Nou. Unfortunately, we do not know the way these markers were created or named after a village's inhabitant (Fig. 5).

Does it mean that the regional administration relied on the peasants' memory—and also conflicting interests between villages—to guarantee the stability of the geographic markers? Nothing is less certain. Near the inhabitant's name, we can sometimes recognize the name of administration employees. In Újpécs, the district governor is mentioned as responsible for marker number 5 and a local engineer as responsible for marker number 38. In Gyrr (today Giera in Romania), the map drawn after the 'Reambulation' of 1783, shows a double identification system for the geographic markers (MOL, S 12 Div 10 Nr. 30). In the vernacular language (Serbian), an isolated house or a mound with the name of an inhabitant is mentioned near every

Fig. 5 Markers of the border of the Giera's lands, 1783 [*left*, MOL, S 12 Div 10 No 30], and of Peciu Nou, 1784 [*right*, OeStA, FHKA, Kartensammlung, L 020] (*Courtesy* of OeStA, Vienna and MOL, Budapest)

marker. Then, a short German inscription mentioned another person responsible for the marker: it could be a district employee (a secretary, an engineer, a tax-collector, the governor or a vice-governor), an estate's landowner (in this case Lukas and Anton Gyertyarffy), or, more surprisingly, the mother, the wife, a daughter or a son of those employees or landowners. This last solution allows noting a different name for each marker, insofar as the number of district employees rarely exceeds twenty persons whereas geographical markers are usually more numerous on one map.

This reflects the need for the administration, which also represents the estate land owner in the Banat, to assure its control over its land tenants. This double geographical identification system cannot be seen as a sign of mistrust towards local worthies or simple peasants, considered as unreliable because they did not belong to a rational State machinery. Indeed, this interpretation does not clarify the social role of this map. It is not a cadastral map in the sense of a document produced by a modern State to calculate the level of a land tax and to guarantee the limits of private property. Of course, those two dimensions are certainly present in the context of the reform of division of lands implemented between 1772 and 1779. The Habsburg's administrators and Joseph II himself considered this reform, the division of lands and the introduction of individual plots, as a means of modernization. The cadastral maps were considered as signs and as guarantees for this modernization and the durability of the changes imposed. But insofar as Banatean farmers remained serfs—and not just subjects—of the sovereign, the taxes they paid cannot be considered as mere land taxes: they are also feudal charges. This last example helps us to remember that this type of map is the geographical expression of the rights and duties of the famers towards their lord. That is why the identification of geographical markers is not only a technical issue for the engineers-cartographers. The nomination of administration employees or their relatives to be proof of the location of borders markers, even if they are not familiar with this area, is a consequence of the social separation between the group of the representatives of sovereign/land owner and the peasant communities living and working on his estates. But it is also possible that, in certain cases, the responsibility for a border's marker could be entrusted to local worthies, insofar as they were chosen and confirmed by the authorities and not imposed by the rural communities.

4 Conclusion

It is not easy to define the nature of the cadastral maps of the Banat which were produced and used at the end of the eighteenth century. The maps appear to be instruments used to rationalize and modernize land management and even the local rural society, which the engineer and the 'enlightened' administrator of Vienna and Temesvár often considered as backward. But the ambiguity of the State's power in this region—landowner and sovereign—is the most important reason for this difficulty. To some extent, the subjects and the village communities did not remain totally mute or passive in this process because they could indirectly influence the surveying and the mapping of their lands. These possibilities were guaranteed by the conciliation procedures led by the so-called ‘local directions’ during the first attempts to divide the villages’ lands. But after the production of the first cadastral maps was completed, the villages ceased to be actors of mapping and surveying. The cadastral maps conserved in the district administrations served as tools of estate management and of social control: they could help the administrators to establish new settlers on free lands, reinforce their control on the villages’ internal and external borders and, as a consequence, guarantee a certain stability of the population and of the charges and tax payment. After a first phase during which the use and the way to construct the cadastral maps was still uncertain, their use becomes more widespread, very similar to the estates’ ‘urbarial’ maps of the kingdom of Hungary at that time.

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The Historical Evolution of Craiova Municipality (Romania) Results from the Analysis of Cartographic Documents

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Abstract Craiova, one of the largest cities in Romania, is located in the south of the country, within the Romanian Plain, at 44º 3′ North and 21º 2′ East. The altitude of the area varies between 75 and 116 m. The city developed along the Jiu Valley, at the junction between the Oltenia Plain and the Getic Piedmont. Resembling an amphitheatre, the settlement is bordered by hilly areas in the North, West and East, while in the South, the altitude decreases towards the Danube Valley. This is the main factor that imposed the southward development of the city, as in the West, where it was a favourable flat area, namely the Jiu floodplain, until 1970 there used to be a marsh, due to spring high waters. This paper aims at reconstructing the position of the settlement in cartographic documents starting with the Tabula Peutingeriana (dating from the Roman period), Constantin Cantacuzino's map (1700), Fr. Schwantz (1722), and the map of the Romanian Principalities (1790), ending with the contemporary period and the era of digital maps. We also use historical–geographical documents from Antiquity, the Middle Ages, and the present times which mention the settlement or the area in which the city is located. We also aim to emphasize the growth of the city by illustrating the spatial–temporal stages using large scale cartographic documents and correlating this growth with the events that imposed certain distortions from archetypical urban structures.

1 Introduction

The territory of our country was little known from cartographic materials until the eighteenth century. Previously, through the Flemish School (the works of Mercator, Ortelius, Hondius and Vischer), and the French School (whose forerunner was Sanson) small scale maps that showed the area of the present Romanian territory reproduced the longitudinal errors from Ptolemy's maps, which led to errors in settlement locations or distances between settlements. Until the time of Ptolemy, none of the cartographic documents had succeeded in rendering correctly the borders, or

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its size, in case of the Carpathians. The Danube along the sector crossing Romania was not well known either; during this period its source was discovered by Marsili (Toşa-Turdeanu 1975), and starting from that time, it appeared on different maps, as well as the three branches of the Danube that flow into the Black Sea.

During time, there were of course certain exceptions, due to the strategic importance of different locations within the Romanian territory; here we mention Hecateu from Milet (540–470 BC) who, in his book Trip around the World (*Periodos ges*) demonstrated a knowledge of the "Crobizi" and the "Trizi", ancient Thracian tribes related to the Gets from Southern Dobroudja, and mentioned the Orgame fortress located near the Istru (the Danube). This fortress will be also mentioned later in other historical sources, as being located in proximity to Argamum, which is the present town of Jurilovca (Popescu-Spineni 1978).

Among the large scale maps that have to be taken into consideration, we should mention the maps drawn by Constatantin Cantacuzino (1700), and Fr. Schwantz (1722) or Specht's map (1790), due to the fact that they showed the area of Wallachia with many fewer errors than previous cartographic materials, even if there were not so many details. Specht's map (Fig. 1) showed the location of Craiova within the Jiu Valley; at the same time, there also appears the Cornițoiu Valley (in the northern part of the city), which will be later divided by the railway and then by the Decebal Boulevard, as an integral part of the city's inner belt. In this cartographic document, there also appeared some of the present suburban settlements, such as Bucovăț or Treaka (afterwards Uscăci and presently Rovine), as well as Albești, which is located further away.

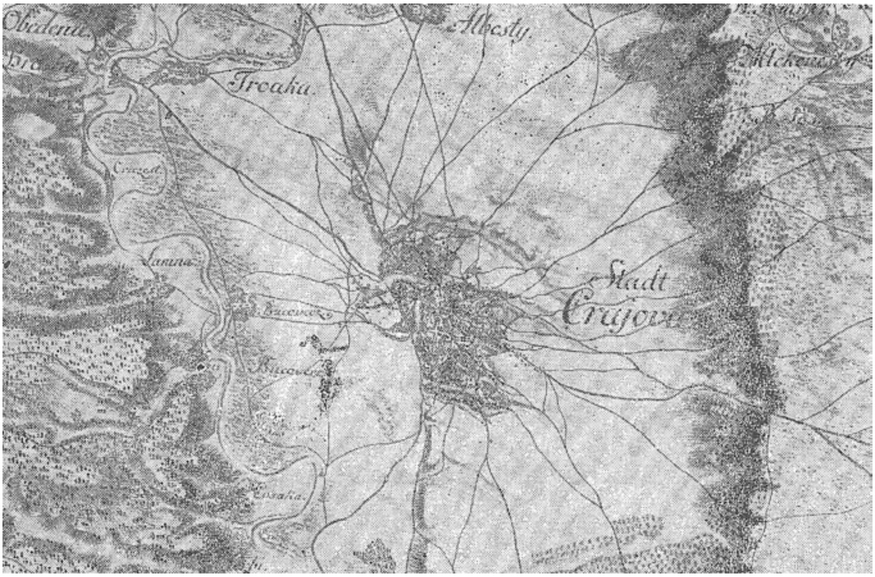

Fig. 1 Craiova city rendered on Specht's map (*Source* Toşa-Turdeanu 1975)

2 The First Cartographic Representations of Craiova City

The oldest and best map of the territory of Dacia dating back to the Roman period, is the Tabula Peutingeriana. This document, made up of 11 map sheets, is a copy (achieved by a monk from Colmar in 1265) after an original map from the second and third centuries. This first cartographic document is a hand-painted map that shows the provinces of the Roman Empire. The surface of the provinces is crossed by broken lines that represent the road network, the main settlements, and the distances between them. The unit of measurement used for showing the distances between the main stations was the *millia passum*. The map is 6.82 m long and 0.34 m wide, consequently the seas and the continental margins are narrower than they should be. The orography is schematically rendered by hachures and the hydrographical system is shown through lines of the same thickness. The practical concern with transport during the period of Roman expansion determined the map's shape and the pattern of graphical representation as the main elements represented are roads and passes over different water bodies and orographic obstacles. In case of the itinerary in Dacia, the toponymy of the settlements is both of Roman and Dacian origin.

With regard to Roman Dacia, the Tabula Peutingeriana (Fig. 2) depicts three or possibly four roads. One of them, which crossed the Lower Dacia, started at Drobeta Turnu—Severin (Drubetae), along the limit of Upper Moesia for about 31 km. The road crossed the Getic Plateau up to the settlement of Motru (Amutria), and 52 km to the south, it reached Pelendava (Craiova). As an oiconym, there is no doubt that the origin of the name of Pelendava is of Thracian-Getic origin. The root of the name is considered to be the word '*peled'* which means either moist or to flow (Pospai 2003); the physical reality and the topographical features of area of Craiova, which is located in the Jiu Couloir correspond to this description.

Under Roman domination, the town (Pelendava) stopped developing and became a village. The functions of the settlement during this period were only military and fiscal as it was a customs post. The archaeological artifacts are represented by different construction materials from the Mofleni fort, the bricks of

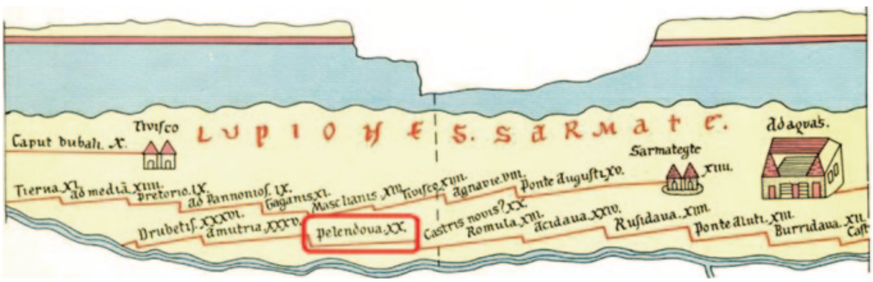

Fig. 2 Fragment of *Tabula Peutingeriana* rendering the location of Pelendava fortress (*Source* tibiscum.uvt.ro/harti/tabula.jpg)

Fig. 3 Sf. Dumitru Cathedral (*Source* Buce-Răduț 2008)

which were later used to build the walls of the monastery in the same settlement, as well as for the foundation of the 'seven springs' near Sf. Dumitru Cathedral (Fig. 3).

In 332, the Craiova area was again under Roman domination during the rule of Constantine the Great. It remained under the Roman domination for about a century, until 422–447, when the fortified line of the Danube, known as *Brazda lui Novac,* was breached by migrating tribes. The remains of this defence system appear in the Bucovăț forest, at Leamna, in the proximity of the Sineasca cemetery, along the street with the same name and across the railway in the area called Bariera Vâlcii (Pospai 2003).

As there are no cartographic documents attesting to its origin, we should mention the first historical document where the name Craiova appeared, in a reference to the settlement located within the lower valley of the Jiu. On the 1st of June 1475, the chancellor of the ruler Basarab Laiotă cel Bătrân issued a document through which the boyar Stanca and his brother received some villages. A witness, *Neagoe boyar from Craiova,* is mentioned in this document. Different historical studies that tried to uncover the origin of Craiova demonstrated that the appearance of the settlement is linked to a Cuman ruler 'King Ion' and it was established by the period 1230–1235, when the settlement triggered a war between the Serbian Emperor Ștefan Duşan and the Romanian King Alexandru Basarab.

3 The First Large Scale Cartographic Documents of the City

In the cartographic documents dating from the period of the first reference, the fourteenth to fifteenth centuries, Craiova is mentioned with a series of estates and with a reduced number of buildings. The main estates overlapping the perimeter of the future city were: the Craioveştilor Neagoe Estate, Buzeşti's Property and the Domnească Estate (Fig. 4). Among the elements of the former natural landscape there are two valleys, Valea lui Opincă and Valea Orbeților, which are presently streets, namely Calea Bucureşti and Mihai Bravu, as well as the springs near the present Jiu Hotel.

The eighteenth century is significant for the spatial development of the settlement as numerous edifices were built—Casa Băniei (1699); the churches Tuturor Sfinților (1700) and Sf. Ilie (1720); the Obedeanu Monastery (1730); the seven fountains; the inns Hurezului, Ciobacului, Hagi Enuş, Paharnicului Nicolae; crude public oil lighting was also introduced as well as postal services; the Obedeanu hospital (1754–1794) was also built. The plan of the central area of the settlement

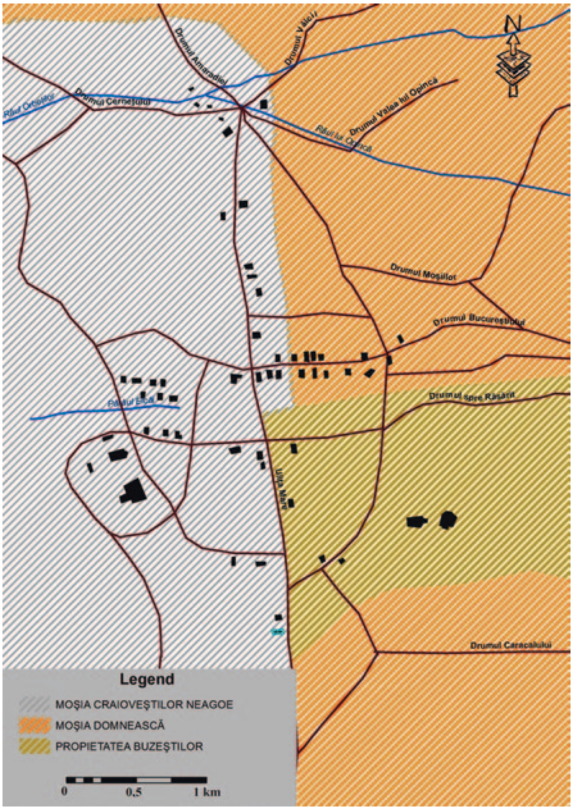

Fig. 4 Craiova in the 14th–15th centuries (*Source* Avram 2010*; processed after: Reconstituire plan Craiova secolele XIV – XV, Arhivele Olteniei*)

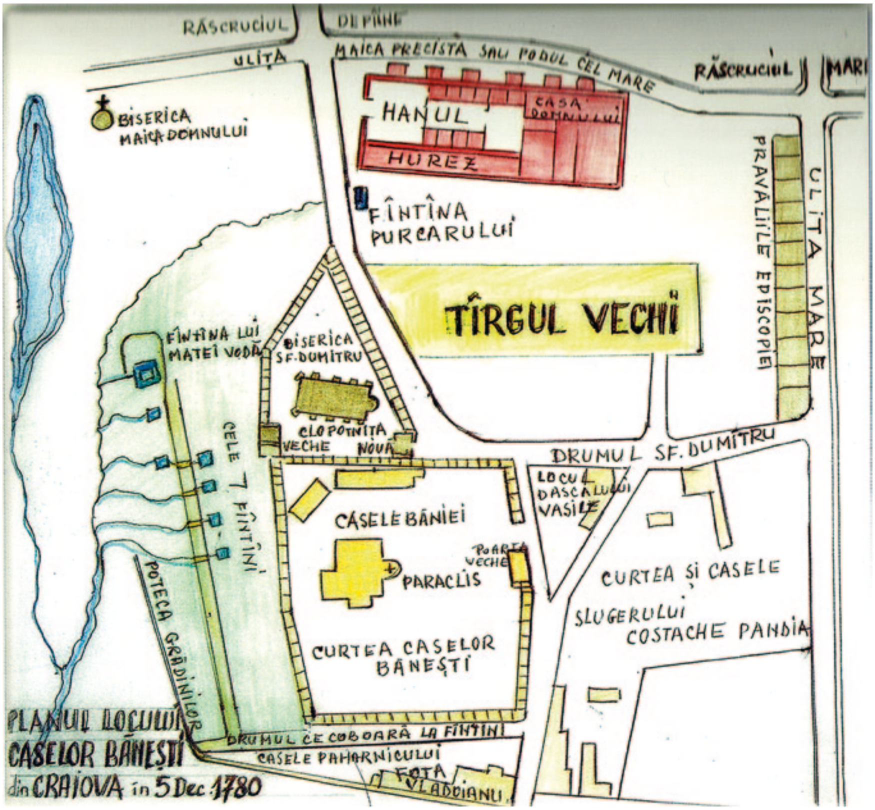

Fig. 5 The centre of Craiova in 1780 (*Source* Buce-Răduț 2008—*after the map achieved by D. Bălaşa*)

shows that urban activity was concentrated around the church, the market and the inn, in immediate proximity to the fresh water source, namely the seven fountains (Fig. 5).

The chronicle of Moldova Country written by Miron Costin emphasizes for the first time the regions of country of Moldova, the regions under Turkish occupation, and the Munteneşti regions (Muntenia Region). Craiova is mentioned as a country ruled by 'bani', located near the Mehedinți country and the Turkish province of Raşava (present day Serbia).

After the revolution of 1821, the city was under Turkish occupation for almost one and a half years, which meant it went through a period marked by repression and abuses. Thus, the economic life of the city was greatly affected and, consequently, many merchants and intellectuals left the settlement. The suburbs of the city were also affected and the peasants moved to mountain villages. By the end of the eighteenth century, the city had developed again (Fig. 6); an interurban road system had appeared, with buildings from that period on both sides. The churches

Fig. 6 Craiova in the 18th century (*Arhivele Olteniei, Fond V*)

continued to be the central elements enabling the development of residential areas. The urban structure did not follow a strict urban plan and thus the city developed according to the necessities of residential space.

The map created in 1831 by Grigore Pleşoianu, showing the Romanian post offices and the quarantine stations, demonstrates the topographic knowledge of the time. The signature of G.C. Heinrich who worked in Sibiu, at the Lithographic Institute 'Michael Bielz', also appears on the map. In 1833, the Administrative Map of Wallachia was also published, drawn by the Geographic Institute from Wien at a scale of 1:420,000. This map was afterwards translated and reproduced in Bucharest and used by the postal service. As it was a small scale map, their main interest was to settle correctly the distances between settlements.

In 1832, in Craiova there were 17 factories, 16 leather workshops and one for garments. The general aspect of the settlement was that of a burgh or burghs gathered within the precincts of the settlement (T. Arghezi), dominated by shops. The reforms carried during the reign of Al. I. Cuza marked the evolution of the city, which, at the beginning of his rule, reflected the transitional state of the Romanian economy between feudalism and capitalism. During this period, Craiova had about 25,000 inhabitants and was the second largest city in Romania after the capital. There were 4,633 buildings, 3,220 of which were houses, 26 churches, 11 schools, 60 factories and workshops (Georgescu et al. 1977).

In 1836, the map drawn by Zaharia Karkaleky of post offices and quarantine stations in Romania with dimensions of 340 × 190 mm was published. On this map, post offices are shown as circles, and quarantine stations and towns through

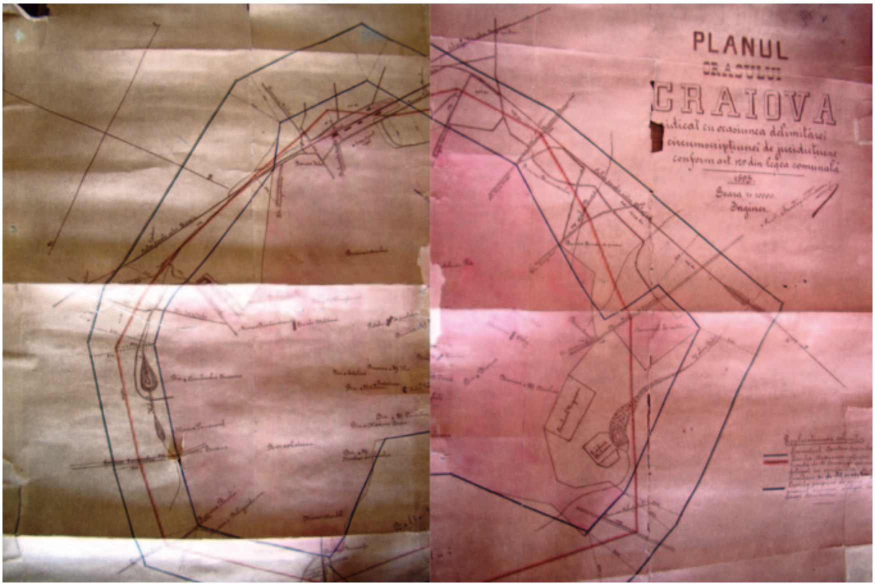

Fig. 7 The limits of Craiova in 1895 (*Source Arhivele Olteniei, Fond V*)

buildings; road connections appeared as straight lines and relief through hachures. In 1895, a map showing the first administrative limits of the city (Fig. 7) appeared, as, due to urban sprawl, it was necessary to correctly show the limits of the urbanized space.

Located in the centre of the county with the highest population in the country and one of the largest agricultural productions (which adapted to the economic demands of the period through the introduction of technical plant and the increase in cereals, especially wheat, in demand for export), Craiova became an important centre in the processing and sale of these goods. Economic life was marked by the presence of small factories, manufacturing chemicals and metallurgical products, agricultural machines and tools, etc., which met the needs of agriculture in the Oltenia region. Almost all industrial companies from Craiova focused on the processing of agricultural products, this being the main feature of the city's industry.

The increase in the population determined further progress in the municipal field, but we cannot discuss a genuine systematization of the districts as rich citizens did not respect the most elementary rules of urbanism. After 1880, the main streets from Craiova were Calea Unirii, Justiției Street, Gării Boulevard, where certain systematization was also experimented with. The streets were paved with artificial basalt, grit stone or porphyry imported from Switzerland, France and Belgium, sidewalks were built, and trees planted along streets. The first electric lights functioned at the Theodorini theatre in 1887 (Stoenescu 2011). Starting in 1895, the city benefited from its own electric power plant. After 1890, public sanitation services were introduced, the main city sewer, public a bathing house, a slaughterhouse and a new market were also built (Fig. 8). Even if there were some

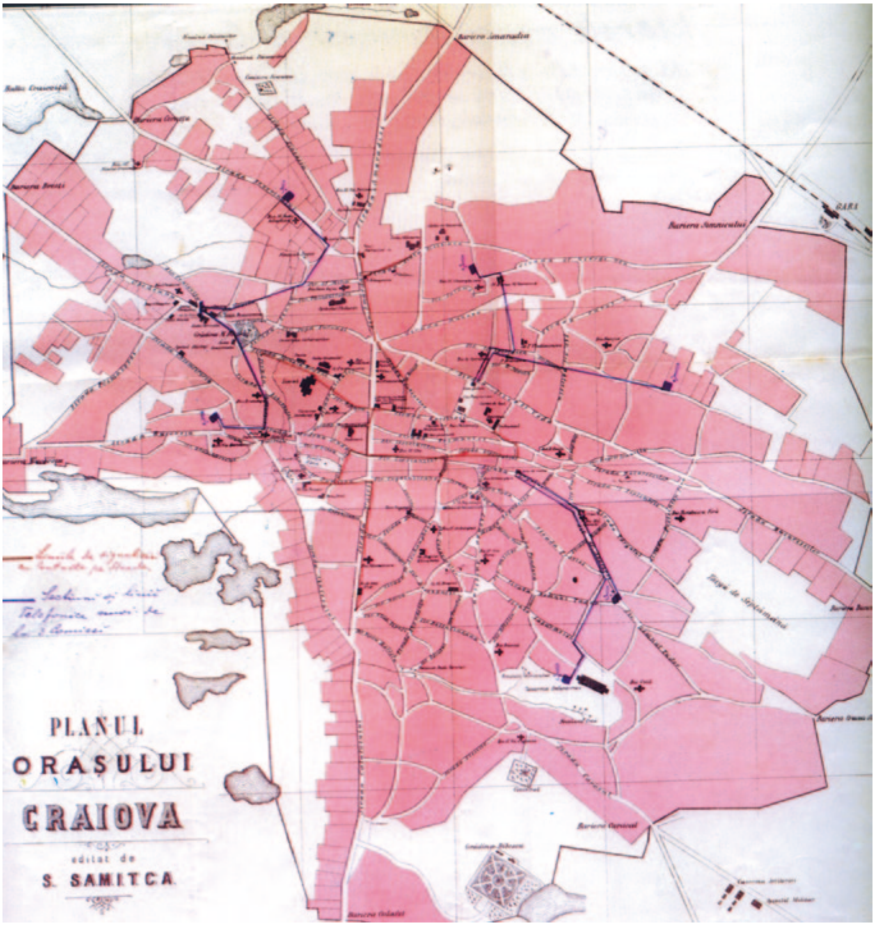

Fig. 8 The situation of the city in 1916 (*Source Arhivele Olteniei, Fond V*)

vehement discussions, the supply of the city with fresh water, the construction of the sewerage system and the introduction of trams were postponed for many years.

In spite of all these problems, the general aspect of the city changed as numerous public or private facilities were built. The architectonic styles varied—Renaissance, Baroque, Classic, Neoclassic, Romantic, Romanian etc., as the constructors were generally Frenchmen, Italians, Germans, but also Romanians. Numerous parks and gardens were built and public monuments erected. Thus, between 1901 and 1903, Bibescu Park of about 100 ha, in a Romantic style after the plans of E. Redont, a French paysagist was constructed. Lunca Jiului, a park-forest covering a surface of 60 ha, and the park Dinu Mihail, were also laid out (Deaconu and Gherghe 2011).

The data from the 1930 census, when 1,240 industrial companies with 5,530 employees were registered, conclusively emphasized the reduced economic

Fig. 9 The systematization plan of Craiova city in 1971 (*Source Arhivele Olteniei, Fond V*)

development of the city. The companies were mainly handicraft workshops and they represented the main feature of the city's industry for a long period. In 1971, the first territorial urban plan (Fig. 9) appeared, which showed the situation of the city marked by forceful industrialization and the construction of the largest residential district.

Practically, Craiova municipality experienced unprecedented sprawl during this period; there also emerged a specific conception of construction, namely the placing of new residential districts at the outskirts of the city, on vacant land plots, in order to preserve the valuable architectural heritage within the city's historical centre. However, at the same time, the idea of 'plombe' (cavity filling) developed,

Fig. 10 Functional zones of Craiova in 1971 (*Source Arhivele Olteniei, Fond V*)

namely placing new construction in available areas located in the old centre of the city or in those areas occupied by buildings without urban value. The functional zoning of the urban perimeter developed in the 1970s (Fig. 10) is still being used by the planners working for local authorities, in spite of the fact it no longer corresponds to the reality of the urban fabric.

After 1990, the spatial development of the city ceased. In the first years after the collapse of the communist system the number of inhabitants increased but the development of residential areas was not intensified. At a slow rate industry began to collapse due to the lack of orders. It was the period of important social movements and only a small number of inhabitants got rich, while the others struggle to cope with monthly expenses. Thus, after reaching its maximum number of inhabitants in 1990 (Fig. 9), the general trend was a decreasing one. As all major industries were closed, employees were dismissed in huge numbers. The automobile factory was confronted with this situation several times; it was initially purchased by Daewoo, and more recently by Ford. The destruction of the former industrial base is confirmed by the development of other tertiary units within their precincts (Helin Hotel at the Plane Factory, Auchan Mall at Electroputere Platform, etc.). Thus, began the emigration of the labour force to the states of the European Union and America, and on a lesser scale towards rural areas.

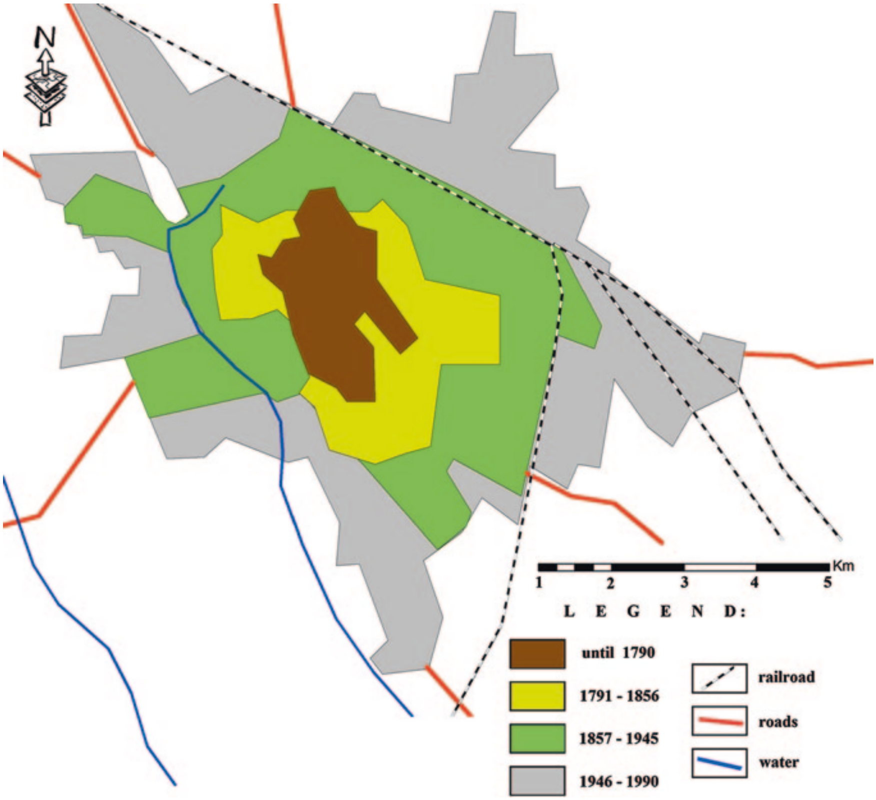

Fig. 11 Spatial evolution of Craiova between 1790 and 1990 (*Source* Avram 2010*; processed after* Atlasul României 1979)

As a result, the territorial development of the city has been closely correlated with the economic activities performed in the settlement. If initially, during the Roman period, Craiova played a strategic role as an outpost, it fell into decline during the Middle Ages, as well as the entire Oltenia region, and consequently, it is little mentioned on different cartographic documents. Consequently, we may state that the settlement began its existence as a city starting in the nineteenth century as agriculture developed, but urban expansion was quite slow. This stage of the city's expansion was shown in the initial measurements from the inter-war period.

The real spatial development of the city occurred after 1970, once the forceful industrialization process began. This new expansion stage was shown on the urban zoning plans drawn at scales of 1:5,000 or 1:10,000. The last period, after 1990, was depicted only in local studies based on the processing of satellite images, but no up-to-date cartographic documents were produced for use by the local administration (Fig 11).

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Author Biography

Avram Sorin is a lecturer in the Geography Department of the University of Craiova where he teaches cartography and territorial planning. His PhD was obtained in 2011 at the University of Bucharest, Faculty of Geography, with research into the Craiova rural-urban fringe expansion and its environmental impact. He graduated from the University of Craiova, specializing in Geography and Italian language and literature, and he also obtained a master's degree in Economics and Environmental Management from the Bocconi University, Milan. His publication of scientific material focuses on the spatial and historical analysis of geographical space, using specific geographic data and its modeling by means of GIS. His current work focuses on urban planning and urban sustainability, urban growth in the rural-urban fringe of metropolitan areas, and spatial transformations in the Oltenia Development Region using various cartographic products. The results of his research have been published in twenty-six scientific papers and 3 books.

Alina Vladut was born in 1978 in Tg. Jiu, Romania. She completed a B.A. (2001) in Geography and English at the University of Craiova and a PhD (2006), in the field of Climatology, at the University of Bucharest. One year after graduation, she started teaching at the Geography Department of the University of Craiova. She currently teaches different courses in the field of Climatology, and guides both B.A. and M.A. students in achieving their graduation works by placing strong emphasis on individual needs, analytical and practical skills. Her research interests revolve around climate studies—present trends in the south of the country in the European climatic context, the impact of climate change on various components of the environment, etc. Based on the results of her research, she took part in more than 40 national and international conferences and published 43 scientific papers and 4 books in collaboration with other colleagues. She was also a member of a team who undertook 8 national, and 3 international research projects.

Curcan Gheorghe obtained a Bachelor's degree, a Master's degree and his PhD from the Faculty of Geography of the University of Bucharest. He is currently a senior lecturer in the Department of Geography of the University of Craiova. He has been a member of various research teams involved with national and international projects and his scientific activity is proven by 44 papers presented at different scientific meetings in Romania and abroad, and 46 articles published in prestigious journals. He is a long-standing member of the editorial staff of various scientific journals, and a member of scientific societies and specialised research centers such as the Romanian Geographical Society, the Romanian Association of Geomorphologists, the Centre for Environmental Research and Sustainable Capitalisation of Resources, and the Centre for Research-Innovation in Regional Tourism. In a didatic capacity, he teaches on both the undergraduate and graduate levels.

Part II
Asia and Africa

A Brief History of the Boundary Mapping Between Indonesia and Timor-Leste

Sri Handoyo

Abstract During the years 1997–1998 Indonesia was in a very serious crisis (economically, politically, and socio-culturally) as also happened in other South East Asian countries. In this period, there was political pressure from the people in the Province of East Timor and the international community directed at the Indonesian Government, demanding a referendum. In 1998 the Indonesian Government agreed to hold a referendum with two options: to obtain independence or stay as part of Indonesia. In 1999, a referendum was conducted in the Province of East Timor under United Nations supervision. The referendum resulted in around 80 % of the East Timorese people choosing independence and separating from Indonesia. Finally, on 20 May 2002 East Timor declared itself an independent country called the Democratic Republic of Timor-Leste (RDTL), and was assisted by the UNTAET (United Nations Transitional Administration in East Timor). Under the Joint Border Commission between Indonesia and UNTAET, a joint technical sub-commission for border demarcation and regulation was established to establish a border between Indonesia and Timor-Leste, and a work plan to carry out the land border survey and demarcation was agreed upon. The main references were the 1904 Treaty between the Dutch and Portuguese, and the Permanent Commission Award 1914 (PCA 1914). This paper describes the brief history of the boundary mapping between Indonesia and Timor-Leste as the implementation of the geopolitical will and joint geospatial frameworks.

1 Introduction

For more than 20 years Timor-Leste was the 27th province of Indonesia, namely the Province of East Timor. The years 1997 and 1998 were a time of crisis for Indonesia, in economics, politics, and in the socio-cultural area, as also happened in other countries such as Singapore, Malaysia, Thailand, and the Philippines. During these years, there was political pressure from the people in the Province of East Timor on the Indonesian Government demanding a referendum. President

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Fig. 1 Indonesia and the island of Timor

B.J. Habibie of the Republic of Indonesia decided to agree on a referendum with two options, (1) obtain independence and separation from Indonesia, or (2) stay as part of Indonesia. In 1999, the referendum in the Province of East Timor was conducted under the United Nations and resulting in around 80 % of the Timorese choosing to have independence and to separate from Indonesia. Finally, based on the referendum of 30 August 1999, Timor-Leste became an independent country on 20 May 2002 as the Democratic Republic of Timor-Leste (RDTL). See Fig. 1 above, the location of the country of Timor-Leste in the Island of Timor (in light box line) in relation to the location of Indonesia.

The brief history described in this paper relates to the independence of Timor-Leste. The work plan to establish the land border between Indonesia and Timor-Leste had been initiated by Indonesia and the United Nations Transitional Administration in East Timor (UNTAET) with reference to the 1904 Treaty between the Dutch and Portuguese, and to the Permanent Commission Award 1914 (PCA 1914). It was started in 2000 with the forming of a Joint Border Committee (JBC), in Indonesia chaired by the Director General for General Governmental Affairs, and a Technical Sub-Committee on Border Demarcation and Regulation (TSC-BDR), in Indonesia chaired by the Chairman of BAKOSURTANAL. This was followed by JBC and TSC-BDR meetings in 2001 and 2002. After the independence of Timor-Leste, there was the first meeting of the Joint Ministerial Commission (JMC), of both Indonesia and Timor-Leste Ministers of Foreign Affairs, in 2002 that instructed the TSC-BDR to carry out joint delineation and demarcation surveys (Handoyo 2011).

2 Joint Organization and Work

After the independence of Timor-Leste, the formation of a joint organization to work together in a close bilateral cooperation establishing the international boundary between RI and RDTL was a very important step in developing geopolitical good will between the two countries. This step was then followed by many bilateral meetings, both in Indonesia and in Timor-Leste, to discuss matters relating to defining and determining the border points and lines and the implications wherever they occurred.

3 The Joint Committees

The joint organization was started with the Joint Ministerial Commission (JMC) of both Foreign Ministers of RI and RDTL. This was followed by the subordinate committee namely the Joint Border Committee (JBC). The Working Group on Border Issues (WG) and the Senior Officer Meeting (SOM) provide forums for the communication of border issues between the JBC and the JMC. Under the JBC there are various technical sub-committees (TSC), such as the TSC on Border Demarcation and Regulation (BDR), the TSC on border crossings of people and goods, the TSC on police cooperation, the TSC on assets, etc. The TSC-BDR is the TSC that is in charge of the geospatial (surveying and mapping) establishment of the international boundary. Within the TSC-BDR there are a group of related ministerial representatives from both Indonesia and Timor-Leste. In the TSC-BDR meetings many aspects related to surveying and mapping of the border points and lines are intensively discussed. So far this TSC-BDR is the most active TSC among the many TSCs under the JBC. One result of the TSC-BDR was the Provisional Agreements in 2005 between RI and RDTL that has been accepted as the new treaty, although it does not cover 100 % of the entire border lines yet. Figure 2 is the diagram of the border organization.

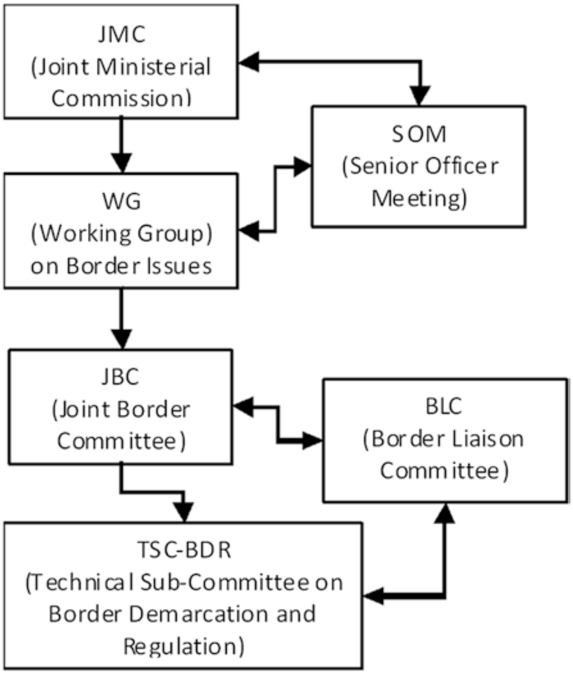


Fig. 2 The organizational chart of RI-RDTL land border establishment

4 The Joint Activities on the International Boundary Establishment

The activities of the two survey teams of RI and RDTL are the joint interpretation of the 1904 Treaty, joint reconnaissance surveys, joint CBDRF establishment, joint delineation surveys, joint demarcation surveys, and joint mapping.

5 Joint Interpretation of the Treaty

The documents of the Treaty 1904 and other relevant documents are studied in order to interpret the Treaty's verbal description of the border lines. Commonly, the verbal descriptions of the Treaty are so general that there is a lack of detail on features along a border line or inconsistencies with current toponymy (Deeley 2001). In general, there is not much discrepancy in the interpretation of the Treaty. Only on some points were there different interpretations made by the Indonesian and Timor-Leste teams. These different interpretations have until recently led to border line problems. Table 1 is an example of the segment description from Segment 1 to Segment 4 within box 15 in the illustration column.

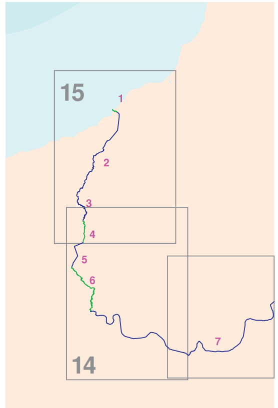
6 Joint Reconnaissance Surveys

The objective of the joint reconnaissance survey is to assess the conditions of work and visit some of the more complex border segments. This is to jointly make traces in the field of those border line descriptions resulting from the Treaty interpretations. The traces in the field can be either agreed or not agreed upon by both survey teams. Again, those disagreements may also lead to problems. An example of a serious border line problem due to different interpretations of the Treaty and in the field is the unresolved segment Noel Besi/Citrana. This problem has implications for about 1,096 hectares fertile land in the west sector of the border (TSC-BDR RI-RDTL, June 2004 and October 2004).

7 Joint CBDRF Establishment

The objective of the joint survey and construction of the common border datum reference frame (CBDRF) is to establish a common border datum on both sides of the border line which is intended to support future surveys and to serve as the coordinate frame of reference for the border line.

Table 1 The description of segment 1 to segment 4 and its illustration

Description	Seg	From	To	Present status	Illustration
From the river mouth of Mota Biku, following the river Mota Biku	1	(714333, 9009203)	T701010	Approximate line	
Following the river Mota Biku up to its tributary We Bedain	2	T701010	T502032	Agreed line	
Following the river We Bedain up to the river Mota Assudat	3	T502032	T502089	Agreed line	
Following the river Mota Assudat as far as its source	4	T502089	T5ASSUDAT	Approximate line	

The accurate delineation of the border between RI and RDTL was a major issue after the independence of the latter country. On some segments, uncertainty about the correct line of the border was high due to several factors (e.g., destruction of old markers, change of river courses, etc.). In addition, accurate surveying of the entire border line in a known international reference frame was required by the two countries in order to solve any possible issue in the future. Therefore, the decision was made to establish a reference frame for defining the reference coordinate system, from then on identified as the Common Border Demarcation Reference Frame (CBDRF). A joint survey to construct the CBDRF established a set of common border datums (the fiducial network) on both sides of the border as the reference frame and as support for the delineation field work. This CBDRF was the start of geospatial work after the independence of Timor-Leste.

The guidelines adopted by the two governments required that ITRF2000 (International Terrestrial Reference System, solution 2000) was selected to map the CBDRF into a known international frame. The observation of the CBDRF network was carried out jointly by RI and RDTL teams using only GPS observations. The total number of CBDRF stations is 69 divided by three classes, defined a priori as a function of the planned number of occupations and hours of observations:

- Zero Order—stations continuously observed during the entire period of the campaigns.
- First Order—stations with a minimum of two daily sessions (each session with a minimum of 12 h).
- Second Order—stations observed with a minimum observational period of at least 2 h.

Figure 3 shows the distribution of the CBDRF stations of First and Second Order.

Table 2 summarizes the specifications for the GPS observations that have been followed:

The results show that the stations of the CBDRF, in particular the Zero and First Order stations, have very robust solutions with respect to ITRF2000. In this way, the accurate connection of the points of the border line between Timor-Leste and Indonesia with respect to a global reference frame is possible. Furthermore, the derived solutions can be used in the future for other types of projects (e.g., geodynamic studies or the definition of national geodetic networks) (Fernandez et al. 2005).

8 Joint Delineation Surveys

The objective of the joint delineation survey was to survey the border line and to survey Ground Control Points. The aim was to jointly identify in the field the border points which constitute the international border in accordance with the 1904-Treaty and 1914-Arbitral Decision, agreed by both parties as the legal basis for the international boundary between Indonesia and Timor-Leste. This survey was carried out together

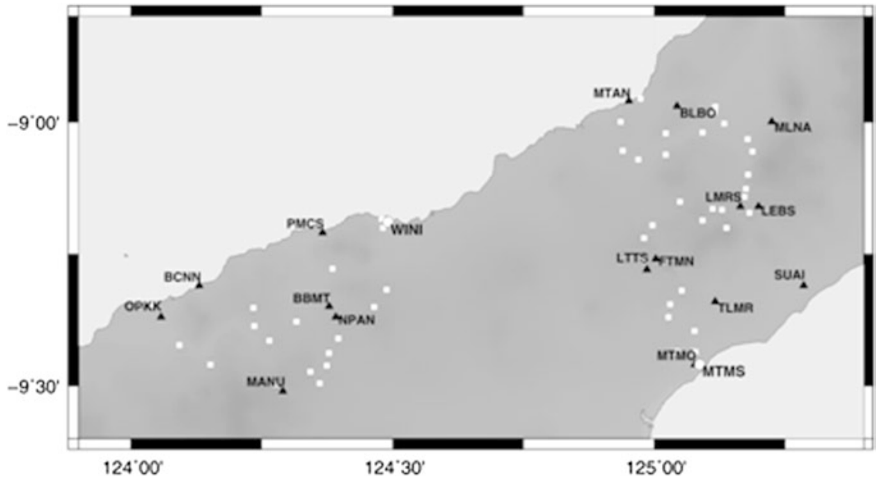


Fig. 3 First order (*black triangles*; nine in Timor–Leste and seven in Indonesia; *labeled*) and second–order (*white squares*; ten in Timor–Leste and 39 in Indonesia) stations of the CBDRF network. Also shown are the two zero-order stations (*white circles*) located close to the border (Fernandez et al. 2005)

Table 2 Major characteristics of the GPS observations of the CBDRF network

Method	Static
Instruments	Dual-frequency geodetic-type receivers
Observation time-span	Continuous (during the campaign) for Zero Order; 2–4 × 24 h for second order
Data recording rate	15 s (30 s for some points of zero and first order)
Elevation-mask angle	10°

with the survey of ground control points required for the use of Ikonos satellite image as the geospatial media (and other related accompanying maps) for visual reference in the field. The joint field work was based on the "Technical Guidelines for Methodology of the Field work for Border Delineation" (TSC-BDR RI-RDTL, June 2003).

The selection of candidate points, for river or non-river boundaries, was made by taking into consideration the need for inter-visible locations and that straight line segments should not have a considerable deviation (less than 10 % of river width with a maximum of 10 m) from the natural feature. The maximum distance between border points should not be more than 150 m. Agreement and surveying procedures were determined in the Guidelines for both river and non-river boundaries. For the river boundary, each GPS position on the river bank should be obtained with 7 min of observation with a code receiver with an observation rate of 5 s. For non-river boundaries there are two possibilities, i.e., with "location of old markers and natural features" and with "watershed and other points". The surveying procedure for location of old markers and singular natural features (such as river sources or summits) was static observation with double frequency receiver for 30 min at a 15 s observation

Fig. 4 The joint survey team conducted a GPS measurement of a delineation point in the middle of a stream

Table 3 List of border points coordinates

Point_ID	Easting	Norting	Type	Class
T103001	662300.58	8985512.41	Provisional	OF
T103002	662256.74	8985452.57	Final	OF
T103003	662190.51	8985529.44	Final	M
T103004	662274.82	8985486.01	Final	M
T103005	662382.25	*8985395.83*	Final	M
T103006	662408.09	8985301.69	Final	M
T103007	662403.72	8985172.46	Final	M
T103008	662414.29	8985071.09	Final	M
T103009	662460.81	8984942.13	Final	M
T103010	662501.63	8984785.41	Final	M

rate. The surveying procedure for watershed and other support points was rapid-static positioning, i.e., 6–15 min observation time at a rate of 15 s, with a double frequency receiver. The data processing for all points was carried using Leica Ski-Pro software, used independently by both sides. The final result was the average of both independent calculations. When the difference between both calculations was lower than one metre, the result was considered final (TSC-BDR RI-RDTL, June 2004). When higher than one metre, or when processed by only one of the delegations, the result was considered provisional. Figure 4 shows the survey teams working together measuring a delineation point.

The following, and Table 3, are examples of resulted border point coordinates, after the proper and procedural processing of the observational data.

8.1 Classification Key

M	Median line point
RB	River bank point
OF	Border point in other feature
HA	OF with high accuracy coordinates
A	Alternative points (for unresolved segments).

8.2 Type Key

Final	Coordinate values are final
Provisional	Coordinate values may suffer corrections (typically of less than 2 m).

Coordinates refer to the CBDRF: ITRF2000/WGS84, UTM Zone51 S (TSC-BDR RI-RDTL, June 2004).

Demarcation of the borderline, in terms of placing permanent border markers, could be executed as soon as the borderline, newly defined by coordinates, had been evaluated by the JBC and agreed upon by both Governments to be the unequivocally defined borderline.

9 Joint Demarcation Surveys

This was the following activity of the joint delineation survey, to establish markers on or between the border points. This activity, the joint demarcation survey, was based on the "Technical Specifications for Border Demarcation" of work version on 23rd December 2004 (TSC-BDR RI-RDTL, December 2004).

1. *Candidates points to be demarcated:*

The process of demarcation was conducted by establishing border markers at selected points along the border line. The selected points should belong to one of the following categories:

a. Surveyed and agreed border points already with final coordinates.
b. Densification points along the agreed approximate border line which thus became final points.

As for the priorities for demarcation, before going to the field for demarcation, both sides decided the selected points or places for the construction of border markers taking the following aspects into consideration:

- the relevance for the description of the border line, mainly where the border point does not correspond to an easily identifiable natural feature;
- the relevance for the activities of the local people, i.e., when daily activities require a clearly visible demarcation to prevent incidental trespassing;
- the spacing between consecutive markers of the border line.

2. *Demarcation methodology:*

There are four possible placements of markers to be agreed upon:

a. Placement of markers in border points with some kind of materialisation.

For the purpose of verification, the position of the newly built marker should be determined again using GPS relative positioning, in conformance with the accuracy established for the border markers.

b. Placement of markers on the approximate border line.

The points of the agreed approximate border line do not have a level of accuracy that requires complex stakeout procedures. These points frequently correspond to natural features, such as watershed lines, that can be identified in the field. In these situations, the approximate position of the point can be surveyed by GPS absolute positioning method using handheld GPS.

c. Placement of markers in agreed border points.

The preferred method for the staking out of agreed border points consist of the following procedure:

- Positioning of at least two auxiliary reference points in the area using static GPS survey connected to the CBDRF;
- The auxiliary reference points will be used frequently and classified as CBDRF densification points;
- Terrestrial stakeout, based on the existing CBDRF points or auxiliary reference points, should be made using a total station with angular accuracy of 1” and distance accuracy of at least 2 mm + 2 ppm.
- In locations where RTK-GPS is found to be suitable for use, it may be used at the discretion of the field team leaders, providing that the base station points are CBDRF points or auxiliary reference points;
- The markers should be adequately recorded.

d. Placement of auxiliary border markers in river banks.

As it is not always possible to place markers along the border line itself, such as cases in which it is located along the median line of a river, auxiliary markers (usually in sets of two, one at each river bank) for the purpose of warning trespassers of

Fig. 5 An example of the border marker facing the East view with a plate showing the Timor-Leste flag (Courtesy of PPBW, BAKOSURTANAL, 2005)

the proximity of the border line may be placed along river banks. The coordinates of these markers should be determined with the same positional accuracy as for the border markers.

Figure 5 is an example of the border marker.

10 Joint Mapping

The joint mapping activity is to produce 17 sheets of joint border maps, depicting the border points and lines, at the scale of 1:25,000 covering both the East (main) and the West (Oecussi) sectors. These maps are based on agreed specification derived from the Indonesian Topographic Map Series at a scale of 1:25,000. As joint maps, every sheet of the map is signed by the head of both delegations, Indonesia and Timor-Leste, in 2004 during the preparation of the "Provisional Agreement". Illustrative example of the index and the map are as follow in Figs. 6, 7, and 8.

All those joint activities were carried out and based on related joint technical specifications and standard operational procedures.

11 Results of the Joint Activities

As a result of the bilateral meetings and the joint field surveys between Indonesia and Timor-Leste, from 2001 to present, the following exist:

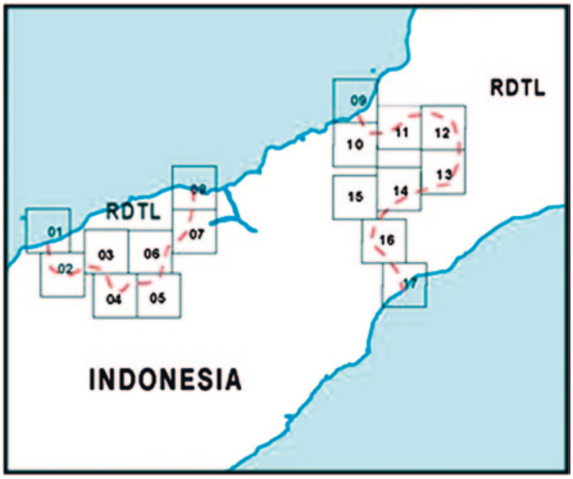


Fig. 6 Index of the 17 sheets at 1:25.000 scale border maps

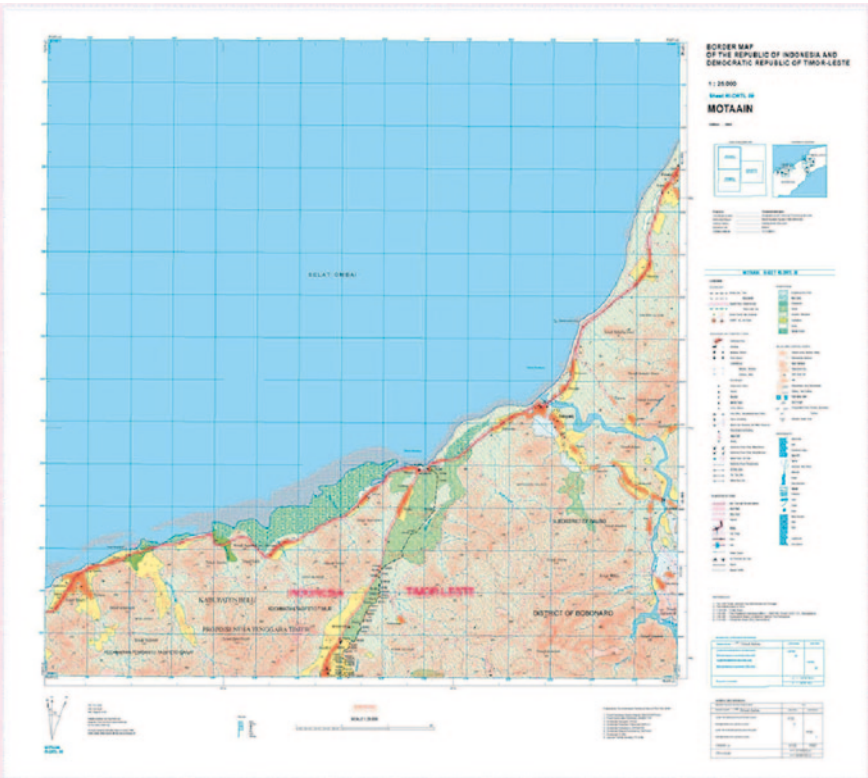


Fig. 7 An example of the joint border map at scale of 1:25,000 (*Courtesy* of PPBW, BAKOSURTANAL, 2005)

Fig. 8 A general description map giving an overview of the entire boundary between Indonesia and Timor-Leste (*Courtesy* of PPBW, BAKOSURTANAL, 2005)

1. Length of the land border lines: the East sector of 149.1 km, and the West sector of 119.7 km, giving the total length of 268.8 km.
2. "Interim Report on the land Border Delineation between Republic of Indonesia and Democratic Republic of Timor-Leste", 2004, consists of three volumes:

   a. Volume 1: Results of the Land Border Delineation.
   b. Volume 2: Description of Process of Land Border Delineation.
   c. Volume 3: Joint Compilation of Reference and Auxiliary Documents.

3. "Provisional Agreement between the Government of the Republic of Indonesia and the Government of the Democratic Republic of Timor-Leste on the Land Boundary", 2005, covering nine Articles and Annexes:

   a. Annex A-List of 907 border point coordinates.
   b. Annex B-1 sheet of General Map at Scale 1:125.000 and 17 sheets of Border Maps at Scale 1:25.000.
   c. Annex C-Unresolved Segments.

4. 103 demarcated border markers.
5. Documents and Record of Discussion (RoD) of: JMC meetings (2), JBC meetings (2), Special JBC meeting (1), TSC-BDR meetings (24).

12 Timeline

1998	During the hard crises in Indonesia, the demand of the people of the Province of East Timor to the Government of Indonesia for a referendum was accepted by President BJ Habibie. For the referendum the President gave two options: stay and be part of Indonesia or be independent and separate from Indonesia
1999	On the 30 August 1999, the referendum in the Province of East Timor was conducted under the United Nations and resulting in around 80 % of the Timorese choosing to have independence and separating from Indonesia
2000	The work plan to establish the land border between Indonesia and Timor-Leste was initiated by the Government of Indonesia and the United Nations Transitional Administration in East Timor (UNTAET) with reference to the 1904 Treaty between the Netherlands and Portugal, and to the Permanent Commission Award 1914 (PCA 1914)
2001	The joint organization to establish the international land boundary was formed by the two countries, Indonesia and UNTAET for Timor-Leste
2002	Finally, May 20, 2002, based on the referendum in 1999, Timor-Leste became an independent country as the Democratic Republic of Timor-Leste (RDTL) The joint activities with Indonesia started with the joint interpretation of the 1904 Treaty and the reconnaissance survey to jointly trace what had been interpreted in the field
2003	In the beginning of 2003 the joint CBDRF survey was conducted June 9, 2003, the joint delineation survey was started, which then resulted in the verified and accepted 907 border point coordinates (after proper joint data processing) The joint mapping (joint production of the border maps) at 1:25.000 scale was also prepared for 17 sheets Eight border problems came up during the Treaty interpretation, reconnaissance and delineation surveys
2004	June, 2004, the Joint Interim Report was produced consisting of 3 volumes. Vol.1: Results of the Land Border Delineation, Vol. 2: Description of Process of Land Border Delineation, and Vol. 3: Joint Compilation of Reference and Auxiliary Documents September–October, 2004, the joint delineation survey was continued especially on the West (Oecussi) sector, resulting in about 250 border point coordinates that are so far not yet been jointly verified and accepted October, 2004, the TSC-BDR meeting in Yogyakarta, Indonesia, discussed the solution for the 8 border problems. 5 problems were resolved, therefore, still 3 border problems remained as un-resolved segments, on the segments of Noel Besi/Citrana and Bijael Sunan-Oben/Manusasi (both are in the West sector), and Dilumil/Memo (in the East sector)
2005	April 8, 2005, the Provisional Agreement was the signed by the two Foreign Ministers on behalf of the Indonesian and Timor-Leste Governments, upon what had jointly resulted, as the new Treaty on the international land boundary between RI and RDTL August 30, 2005, the joint demarcation survey was started with 50 markers erected This was initiated with the survey of the first two markers at Motaain bridge
2006–2007	There was no joint activity, due to internal problem in Timor-Leste
2008-present (2012)	The joint problem solving for the 3 border problems was still in progress but so far it was not resolved Joint activities continue for planning, preparing, and field working other technical work such as border map revision using the latest satellite imagery

13 Concluding Remarks

1. Despite there still being 3 un-resolved segments in existence, the international border establishment was considered as a very quick implementation of the geopolitical good will between the two countries, Indonesia and Timor-Leste. This is about 96 % completion of the total length of 268.8 kilometres.
2. Regarding the solution for the 3 un-resolved segments, both countries should be open minded to look for other possibilities based not only on technical aspects but also on non-technical aspects such as in the form of 'soft border management' schemes.
3. Joint cooperation should be further developed in other aspects of boundary matters for the maintenance of peace and good neighbourly relations.

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TSC-BDR RI-RDTL (December 2004) The 16th Meeting of Technical Sub-Committee on Border Demarcation and Regulation between the Republic of Indonesia and the Democratic Republic of Timor-Leste. Denpasar, Indonesia

Author Biography

Sri Handoyo graduated as a geodetic engineer from the Engineering Faculty, Gadjah Mada University, Yogyakarta, Indonesia, in 1980. Since then he has worked with the National Coordinating Agency for Surveys and Mapping of Indonesia (Bakosurtanal) in Cibinong. He obtained a Post Graduate Diploma in Cartography from the ITC, Enschede, The Netherlands, in 1983. He continued and obtained his Master of Applied Science degree in Computer Assisted Cartography and Digital Mapping, in 1990, from the Department of Geography and Topographic

Science, University of Glasgow, Glasgow, Scotland, UK. In 1994, he followed a short course in Bathymetric Mapping with the Blom Company, Oslo, Norway. His PhD in Geography was obtained in 2002 from the Post Graduate School, University of Gadjah Mada, Yogyakarta, Indonesia.

Since 1984, he has also been a part time lecturer in Geodesy at the Pakuan University, Bogor, Indonesia, a city that is close to Cibinong, where he works with Bakosurtanal. Apart from lecturing in the Pakuan University, he also supervises undergraduate and postgraduate students, in Geodesy and Geography, in other universities.

With Bakosurtanal he has gained experience in managing a number of divisions, such as the Division of Cartography, the Division of Aerial Photography, and the Division of the Mapping of Spatial Planning. He has 8 years experience in the work of boundary mapping especially with the international boundary between Indonesia and Timor-Leste, from 2002 to 2010 as Head of the Indonesian Secretariat for the TSC-BDR RI-RDTL, as well as the Field Coordinator of the Indonesian Survey Team for the Delineation and Demarcation of the RI-RDTL International Boundary.

Currently, he is a researcher with the Geomatics Research Division of Bakosurtanal. His research interests are cognitive cartography, border cartography, and socio-cultural geography. By 2011 he had written 18 scientific papers, presented in national and international semnars and pubished in scientific journals. One of the papers was presented at the “11th International Conference on Computational Science and Its Application (ICCSA)” at the University of Cantabria, Santander, Spain, on June 20-23, 2011.

Colonial Powers and Geographic Naming: A Case Study of Orchid Island (Lanyu), Taiwan

Chia-Jung Wu and Jinn-Guey Lay

Abstract This paper discusses how geographical naming was applied by various colonial powers during their initial exploration and mapping of an indigenous island. In a case study of Orchid Island, we compare the cartographic works performed by three colonial powers during the seventeenth—nineteenth centuries of Taiwan, namely, the Dutch East India Company, the Ching Empire and the Japanese Empire. Instead of documenting the toponymic change, our target is to uncover the strategies of place-naming in accordance with the underlying exploration purposes and cartographic perspectives. Early Dutch and Chinese explorers were found to behave in a similar way by denoting Orchid Island with ambiguous names derived from external societies, simply illustrating a geo-referenced dot on the general maps of Taiwan. On the other hand, the Japanese explorers strived to compile the first large-scale map of Orchid Island with names identifiable with local geography. It should be noted that both political and ethnographic interests were involved with the Japanese mapping of Orchid Island in the late 1890s, which resulted in two versions of toponyms, one is information-driven and the other based on local knowledge. To conclude, heterogeneous ways to deal with indigenous place names were found to reflect different colonial interests and cartographers' interactions with local society.

1 Exploration, Mapping and Geographic Naming

In the practice of cartography, naming a geographic feature is a dynamic process of information gathering, editing and representing. Theoretically, a place name identifies a specific location with its spatial characteristics. However, unlike physical geometry that can be scientifically measured, the name of a place is fundamentally created by its multiple users like local residents, explorers, mapmakers and so on.

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This paper examines how place names of the Pacific Islands emerged on maps from the Age of Discovery up to the late nineteenth century. Maps during this period, by introducing place-names to its portrayed geography, facilitated external powers in demonstrating advanced geographic knowledge and in claiming sovereignty of the explored lands. An island in early western maps often appeared to be empty, as if lending appropriateness for the mapmakers to fill in their favoured geographic names in memory of their discoveries or in honour of their motherlands (Kitchin et al. 2009; Livingstone 2003; Suarez 2004). Hence, cartographic naming throughout the seventeenth-nineteenth centuries has been criticized for its political manipulation and ignorance of local indigenous culture (Simon 1994; Withers 2000; Jacob 2006). On the other hand, the Oriental power of Japan suggested another way in dealing with place-names in their mid-eighteenth century explorations of the northwest Pacific Islands. Japanese maps of Sakhalin, Hokkaido, and archipelagos in this northern region distinctively mark the geographic names in local terms of Ainu people.[1] A pilot research of the indigenous toponymy was then conducted by a Japanese surveyor and cartographer in 1808 (Akizuki 1999: 252).[2] Despite the increasing adoption of western cartographic techniques in the nineteenth century, Japanese cartography retained its method of recording indigenous names whilst colonial interests were well underway. However, the rationale for the Japanese naming practice has not yet been widely discussed and compared with Western discipline in the literature on historical cartography.

As a reflection of the above-mentioned, this study aims to delve into the strategies of geographic naming exercised by different colonial powers. We intend to trace how the place-naming of Orchid Island, an indigenous island off the south-eastern coast of Taiwan, was performed by the Dutch, Chinese and Japanese, who successively established colonial rule in Taiwan from the early seventeenth to late nineteenth centuries. Our motivation derived from a Japanese exploration map made in 1897 that gave the first version of geographic names in local detail, which were absent in earlier Dutch and Chinese versions. By presenting the significant maps at each period in the following article, we focus on specific patterns of place-naming and their associations with underlying exploration initiatives and mapping processes. The key data was collected from archives including *The Zeelandia Diaries,*[3] *The Territorial Maps of Taiwan*[4] and *Archives of the Japanese Government-general of Taiwan.*[5]

[1] The place names of Ainu were mostly rendered in Katakana, the Japanese syllabary to transcribe the phonetics of foreign languages.

[2] The book entitled *Azumaebisu chimeikou* (*Toponym in the Eastern Ezo*).

[3] The Dutch title is *De Dagregisters van het kasteel Zeelandia, Taiwan* 1629–1662. The Chinese translation was done by Chiang and Milde (2000), published by the Municipality of Tainan.

[4] The Chinese title is 臺灣輿圖/*Taiwan yutu*, which includes a series of maps of Taiwan and explanatory reports made in 1877–1878. The volume was reprinted by the National Museum of Taiwan History, and annotated by *Huang* (2010).

[5] The Japanese title is 臺灣總督府公文類纂/*Taiwan Soutokufu koubunnruisann*, which was the official archives of the Taiwan Government-General during 1895–1945. The documents are currently available on the digital database of Taiwan Historica.

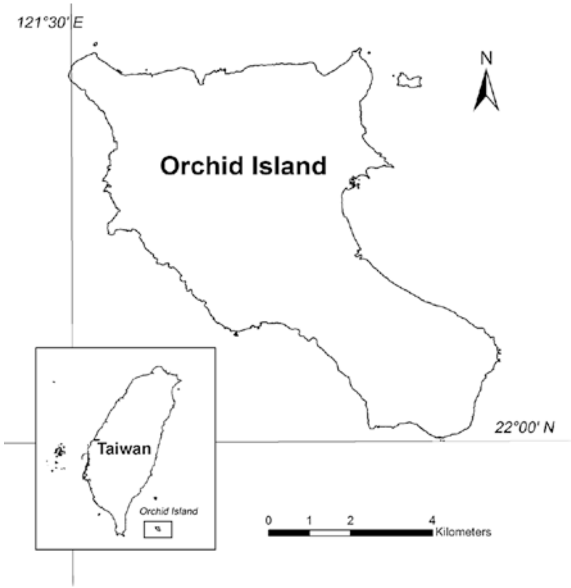

Fig. 1 Geographic location and profile of Orchid Island. (Author's figure)

2 Facts on Orchid Island

Orchid Island is a volcanic island off the southeastern coast of Taiwan, located at 22°03′N, 121°32′E in the West Pacific (Fig. 1). With a surface area of 45 km^2, the island is home to the Tao, an ethnic group of Austranesian origin who are believed to have a close kinship to the people living in Batan Islands north of Philippines since early history (Shih et al. 2001). The inhabitants call the island *Ponso no Tao*, meaning 'the island of people'. Orchid Island represents one of the most significant cultural heritage sites currently under the political rule of Taiwan/the Republic of China. The inhabitants are known for their unique art in making traditional canoes. Although subjected to various colonial influences since the seventeenth century, the island maintained its isolation and traditional lifestyles to a large extent until the mid twentieth century. 'Orchid' became the official name only after 1949 because of the wide acclaim of orchid flowers which are endemic to the island.

3 Dutch Cartography of Orchid Island: 1624–1662

The Dutch East India Company (VOC) played a dominant role in the trade and exploration of East Asia in the seventeenth century. During 1624–1662, the Company established the first colonial rule in Taiwan that provoked a series of mappings of Taiwan and the surrounding sea (Suarez 2004; Gommans and Diessen 2010). At different scales of maps, Orchid Island became identifiable only at the end of 1630s,

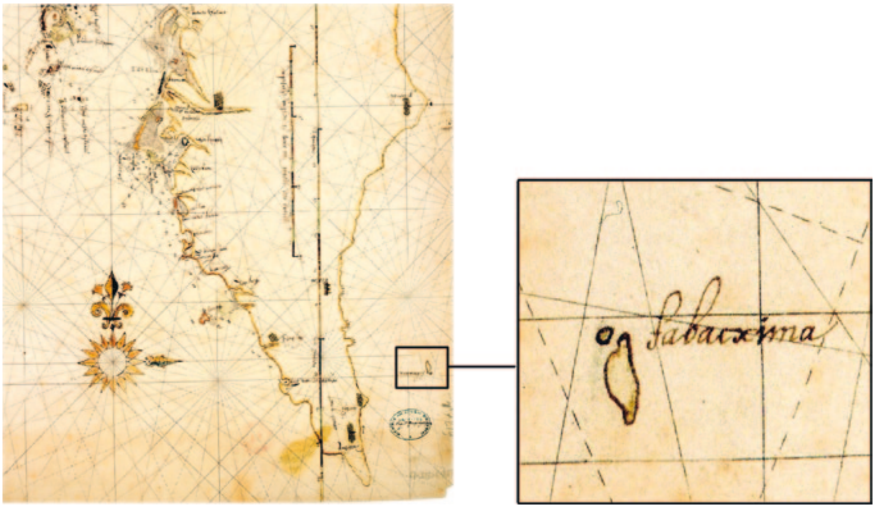

Fig. 2 A section of *Chart of Taiwan* drawn in 1638–1640 (*left*). Orchid Island was labeled as *Tabacxima* (*right*). (*Map source*: Bibliotheque Nationale de France)

with a location fixed to the latitude of 22°N and a name *Tabacoxima* or *Groot Tabacco*, although there is no clear reason for the naming (Fig. 2). From a linguistic point of view, *Tabaco* was evidently not a Dutch word, but Spanish or Portuguese. And *xima* is Japanese for ‘island’. Consequently, the name suggests that the Dutch might have derived the information of Orchid Island from other sources at this early phase of ruling Taiwan. In later Dutch maps and documents, another name *Botol* or *Botrol* was also used to refer to Orchid Island and was considered to stem from an indigenous language in southern Taiwan to describe the insular morphology.[6]

It was not until 1643, the year after the Dutch Company ousted Spanish power from northern Taiwan, that the exploration of Orchid Island was initiated. According to *The Zeelandia Diaries,*[7] the Dutch Government-general of Taiwan dispatched surveyors to Orchid Island at least three times between 1643 and 1645 (Chiang and Milde 2000). The main intension was for security checks to safeguard Dutch power in dominating Taiwan. There were even a few plans to attack or wipe out the inhabitants on Orchid Island (Chiang and Milde 2000: 145, 201). The largest expedition in 1644, with 75 crew members sent, ended up in some conflict with the islanders, who resisted in fear. The Zeelandia Diary of 25th of February 1644 concluded that “there was not much to benefit from this island” (Chiang and Milde 2000: 239–240). The only success of this exploration was achieved by a senior sailor who circumnavigated the island and noted down the island’s topography on a map (Chiang and Milde 2000: 241). However, no authentic manuscript of the relevant map is preserved.

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[6] According to Japanese scholars, the name describes the profile of Orchid Island like a cow’s testicle resting above the sea (Inaba and Sekawa 1931).

[7] Zeelandia is the name of the Dutch fort built in southwestern Taiwan.

The Dutch exploration of Orchid Island did not result in an improved map, as what had actually been done for the Penghu archipelago off western Taiwan, which carried greater geo-political importance for the Dutch company. Throughout the Dutch rule in Taiwan, Orchid Island was portrayed as an empty dot with an abstract outline. The attachment of an ambiguous name such as *Tabaco or Bottol*, simply indicated a geographical location on the sea charts of Taiwan, whereas the local villages appeared completely anonymous and non-existent. On the other hand, *Tabaco* and *Botol* continued to be used interchangeably by other European navigators. The compounded term Botol.Tabago somehow became widely acknowledged to represent Orchid Island for global society until the early twentieth century.[8] However, an interesting response to *Tabac*o was made by the later on Japanese explorers who found that no tobacco was growing at all on this island.[9]

4 Chinese Cartography of Orchid Island: 1877–1878

In spite of the geographic proximity to Taiwan, before the late nineteenth century China had few official records regarding Orchid Island. Although a document dating back to the thirteenth century once mentioned the name *Tan-ma-yen* (淡馬顏), which was thought to refer to Orchid Island (Lin 1958; Feng 1962), no cartographic evidence appeared in the original source.[10] Even after the Ching authority claimed sovereignty over Taiwan in 1684, the Chinese maps had always offered a restricted view of Taiwan with the western half only, leaving the eastern part blank (Lay et al. 2010).

It was not until 1870s that Orchid Island was first incorporated within the imperial frontier by Chinese cartography. Due to the threat of an expanding Japan, who asserted that since eastern Taiwan was omitted from Chinese maps, China lacked sovereignty,[11] the Ching authority decided to launch a grand survey to delineate the entirety of Taiwan, including the outlying islets. With the latest scientific approach introduced by the West, such as gridding by longitudes and latitudes, the project aimed to portray Taiwan as based on its geographic reality (Lay et al. 2010).

In March 1877, an overall survey of Orchid Island was conducted by two students from the Foochow Navy School (*Huang* 2010: 64). This naval academy was newly founded in 1866 in China in order to study Western technology of navigation and

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[8] For instance, *Botol* was adopted by ecologists as the root to form the scientific name *botelensis* for the endemic species on Orchid Island later in the nineteenth century.

[9] The finding of the Japanese expedition in 1897a. The ethnographic explorer Torii Ryuzo pointed out the same too (Torii 1898).

[10] The book is entitled *Zhu fan zhi*, literally the Account of Various Barbarians, written by Chau, Ju-Kua.

[11] Before that, there was a conflict called the *Botan Event* instigated by the Japanese in Hengchun, south of Taiwan, in 1873. Several Japanese were killed by the local tribes. The Japanese accused the Ching dynasty of the neglect of its rule of native peoples.

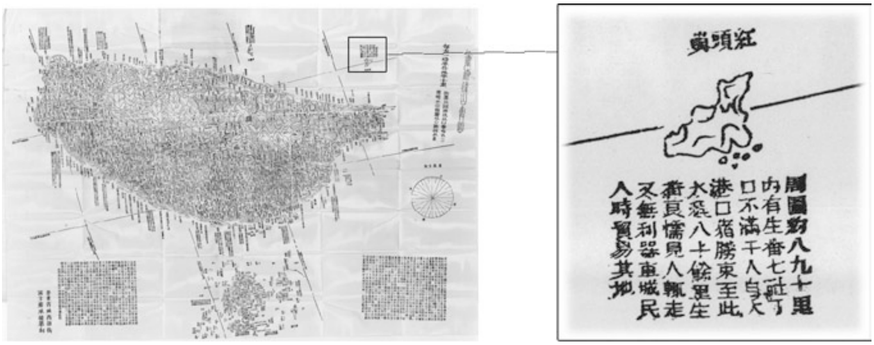

Fig. 3 Orchid Island on the *Territorial Map of Front- and Back-side of Taiwan* drawn in 1878 (*left*). Orchid Island is marked by the name *Hungtou* and noted with some basic facts of the island (*right*). (*Map source*: The Territorial Maps of Taiwan, *Huang* 2010)

ship-building (Hsu 1983: 283). In the resultant map of Orchid Island, compared to the previous Dutch ones, the physical profile of the island was more accurate in the shape of triangle (Fig. 3). Some statistical data were annotated on the map: *The coastal length is eighty to ninety li. There were seven villages and a population of around one thousand.* However, descriptions about local society were few, which in fact reveals a distant view by the surveyor rather than actual contact with the islanders: "*The savages escaped from encounters with foreigners… and carried no weapons….*"

In the finalized territorial map of Taiwan, only the island name was given (Fig. 3). The Chinese seem to have been unaware of the earlier European sources about Orchid Island. They coined the island *Hungtou* according to sayings from the Han immigrants in southern Taiwan. Different interpretations were made around this odd word that literally means 'Red-Head Island'. A common story compares Red-Head to the scenery when the island was viewed at sunrise from the eastern coast of Taiwan (Lin 1958). Another claims that the morphology of the island resembles a Chinese sailing boat called Red-Head (Chiang 1997). There was also hearsay that a tribe of red-haired savages lived in the central mountains (Dudbridge 1999: 86). However, little authentic information was obtained, since there had never been busy trade and communication between Taiwan and Orchid Island, except a number of private visits (Lin 1958; Shih et al. 2001). The name *Hungtou* simply imposed the observations or imaginations of external societies.

The Chinese exploration of Orchid Island did not lead to the establishment of a substantial administration on the island. In a similar view to the previous Dutch, the Chinese surveyors concluded that 'There is no cultivable land or exploitable resource'.[12] Orchid Island was therefore 'drawn' under the jurisdiction of Hengchun as the southernmost county of Taiwan, becoming part of Chinese territory only in a symbolic way (Shih et al. 2001: 29).

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[12] The explanatory export appended to the atlas *The Territorial Map of Taiwan* was made in 1878–1979.

5 Japanese Cartography of Orchid Island: 1897

After the Sino-Japanese war in 1895, Orchid Island was ceded to Japan as one of the 'affiliated islands' of Taiwan under the Treaty of Shimonoseki. While the treaty did not explicitly address what belonged to these affiliated islands, the above-mentioned Chinese territorial map of Taiwan served as the key reference for Japanese to designate its legitimate territory (Lin 1958: 27). Therefore, Orchid Island became a new colony of the Japanese Empire through the transaction of maps.

5.1 First Official Exploration

In 1897, the Japanese Government-General of Taiwan launched a pilot expedition to Orchid Island. Besides the geo-political concern for assuring that Orchid Island was part of the southern frontier separating Taiwan from Spanish power in the Bashi Channel (Lin 1958: 28), the Japanese were keen to make detailed ground surveys. Compared to previous Dutch and Chinese exploration, the survey scale was unprecedented, covering a total of 34 items such as the geographical environment, islanders' political tendency, demographics, religions and rituals, the monetary system, etc.[13] Meanwhile, the expedition was motivated by private interests from mainland Japan. Some entrepreneurs from Tokyo volunteered to join the investigation to explore the exploitable fishing and mining resources.[14] Ultimately, the expedition team consisted of around 35 people, including soldiers, administrative officials and individuals from the private sector. Notably, the journey was expected to be an adventure into the unknown. According to the official archives of the expedition plan, a large amount of pills was prepared to save the crew in case of fatal emergencies.[15] As could be imagined, Orchid Island was still shrouded in mystery by the closing of nineteenth century, regardless of its recognized position on maps.

After the five-day survey, from 14 to 18 March 1897, a map of Orchid Island was completed by two infantrymen and appended to the expedition report to the Government-General of Taiwan (Fig. 4). The map, at a scale of 1/20,000, shows topographic details with contouring in 10 m intervals. However, the map title *Mokusannsokuzu* (目算測圖), literally 'visual-counted map', suggests the measurement was based on viewing rather than by ground survey. In applying this technique, surveyors were trained to visually track distances to separate objects based on a set of rules and facilitated only with handy equipment[16] (Rikugunnshikanngakkou 1896). Such a method was frequently used on the battlefield aiming to capture the geography efficiently. Its accuracy focuses on important geographic nodes such as roads but not

13 Soutokufu (1897b)

14 Ibid, pp. 28–36.

15 Ibid, p. 27.

16 Measurement of distances can be combined with foot counting as well.

Fig. 4 The first large-scale map of Orchid Island completed in 1897 by the Japanese explorers. *The small box at the left* shows the village named by the expedition leader *Kikuchi* and the port named by the fleet *Fukui*. (*Map source*: Archives of Government-General of Taiwan, 000002110569002001 M)

each detail (Shirahata 1892). In the resulting map of Orchid Island, the identified features include villages, hilltops, rivers and footpaths. The fist-like shape of the island is not far from reality, with only slight distortions in the south-eastern section (Fig. 5).

This is the first large-scale map ever made of Orchid Island. However, if the map was created on the basis of visual observation, how did the map-makers deal with geographic naming? In this map, 29 place names were documented,

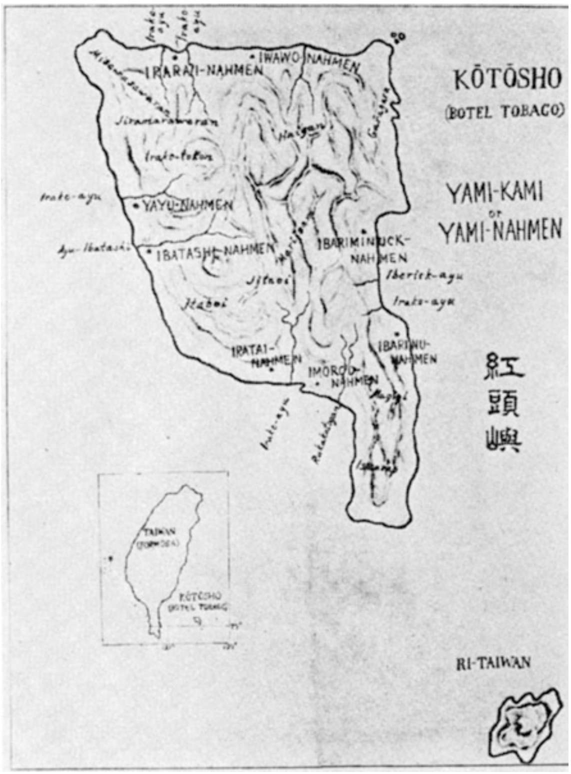

Fig. 5 Torii Ryuzo's map of Orchid Island adapted from the official version (*Map source*: Anthropologic illustration—Red-Head island, Taiwan, Torii 1899)

including 8 villages, 6 mountains, 5 rivers and other topographic features like reefs and rocks. Except that a hilltop was denoted by the Chinese name *Hungtou*, all these geographic features were named using Japanese terms. One major type borrowed the names from the expedition team such as *Kikuchi Village* (菊池村) and *Sano Village* (佐野村). Intriguingly, two mountain peaks, one at the northwestern and the other at the southeastern tip of the island, was named for the two map-makers Tajiri (田尻) and Yamada (山田) themselves. The other type gives a description derived from nature such as *Kinohagawa* (木の葉川), a Japanese metaphor describing tiny streams like 'the leaf of a tree'. There was also an interesting mix such as *Naritaginzan* (成田銀山), which combines the family name of the expedition leader *Narita* and that of a silver mountain *ginzan*.

Whereas naming after explorers might be easily compared to European practice as a patriotic or nationalistic manifestation, Japanese thinking was practical, due to communication problems. In the expedition report, it was stated that "the crew leader Kikuchi gave suitable names for village and other toponyms because there was no way to understand the local language".[17]

[17] Soutokufu (1897c).

5.2 Follow-up Ethnographic Exploration

An immediate follow-up exploration and re-mapping of Orchid Island was conducted by an ethnographer, Torii Ryuzo (1870–1954), who spearheaded the anthropologic surveys in Taiwan and East Asia.[18] As a still young research assistant in the College of Science at Tokyo Imperial University, Torii made the first visit to Orchid Island with a company. During a 3 month stay, from October to December in 1897, he began research in linguistic documentation in order to trace the ethnic origin of the islanders. In an interim travel report published by the Tokyo Society of Geography in 1898, Torii recorded his findings on the geographic names of native people. For each village, he gave the phonetic spelling by Japanese and Romanized syllabary. In the meantime, he made a critical comment on the naming strategy of the previous official explorers:

Each village has its own name. Similarly, they denote a name for each geographical feature including mountains, streams and seacoasts. For instance, they have streams called Ivereck-ayo and Irako-ayo, and mountains Mayigi and Marisan. They seem to give a name even for a small feature. However, the expedition crew created new names, like Kayaba Mountain and Konoha Stream, which were arbitrary. Is this a proper way?
Kotosho[19] *has had its perfect names of mountain, stream and village. We have by no means any reason to import the new names...... For academic concerns, I claim for the necessity of preserving indigenous place- names.*[20]

In a later publication in 1899, Torii adapted the map of Orchid Island from the official copy (Fig. 5). While adopting the same profile of the island on the new map, Torii revised the Japanese names of each village and river according to local usage. In the margin of the map, he also added an adjacent island at the southeast, which was earlier dubbed as *Small Tabacco Island* and *Small Hungtou* by European and Chinese maps respectively. Torii pointed out the toponymic significance of this tiny island in relation to the world view of Orchid Island. *The inhabitants call it Ri-Taiwan, but Taiwan proper by another name 'Buattan'. The reason for these names is worth of future research* (Torii 1898).

Torii's exploration and mapping of Orchid Island could be considered as a pioneering action to claim justice for indigenous place-naming during the heyday of Japanese colonialism. However, it was not clear how his opinion affected the naming politics. The subsequent maps of Orchid Island produced by the colonial government, like the one made in 1904, showed the local names of villages, but combined with a few names created by the earlier military surveyors.

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[18] Torii participated in the newly founded Tokyo Anthropological Society in 1886 and made his first overseas survey in northeastern China.

[19] Kotosho is Japanese for *Hungtou* Island.

[20] The paragraphs in italic were underlined in the original article of Torii.

5.3 Naming Strategies and Cartographic Perspectives

To sum up, the Dutch, Chinese and Japanese explorers all encountered a completely isolated society when first approaching Orchid Island. However, their naming attitudes were obviously different, which on the one hand were associated with their colonial interests in the island, and on the other with the explorers/cartographers' interactions with the local society. For the latter, we identify three cartographic perspectives characterized by the Observatory, Informatory and Participatory approach as follows (Fig. 6).

The first can be illustrated by the Dutch and Chinese explorers, who essentially remained outside observers. Though expending effort in specifying the island's location relative to Taiwan and recording the physical profile, they were indifferent to understanding the indigenous culture. Their descriptions of natives mostly illustrate the fearful reactions and primitive living conditions of the locals. Both the Dutch and Chinese imported the name Orchid Island from the information of external societies, regardless of its ambiguous meanings, simply to confirm a location on sea charts. The local villages completely lacked identification.

The second perspective is presented by Japanese military surveyors, whose paramount goal is to compile the information in a readable way. Their exploration on behalf of the Government-General was carried out comprehensively and practically. Although they gathered human-related data in detail, such as demographic statistics and land-use, the explorers had limited access to communicate with the local society. Still, 'suitable' place-names were introduced by the mapmakers to spatialize the information collected. In other words, the generation of toponyms was information-driven. In contrast, the ethnographer Torii focused on human linkage to the named geography. By using the term 'participatory' to

Cartographic Perspectives	**I. Observatory** (1624-1895)	**II. Informatory** (1897)	**III. Participatory** (1897)
Represented Cartographer	Dutch & Chinese surveyor	Japanese soldier	Japanese ethnographer
Focus of Map Content	(1) Geographical position (2) Physical profile	(1) Topographic features (2) Land-use (3) Demographic statistics (4) Place-names	Place-names
Classification of Place Names	The island name only	The island name, village names and topographic names	The island name, village names and topographic names.
Methodology of Place-naming	Derived from other sources	Introduced by the surveyors	Based on field surveys
Function of Place-names	To identify a geo-reference dot	To identify geographic data	To link geography with local knowledge

Fig. 6 Cartographic perspectives in relation to different naming strategies of Orchid Island

describe Torii's cartographic perspective, we aim to stress that he participated with the indigenous society, to learn local geographic knowledge, beyond just cataloguing the physical geography. What Torii advocated, is that cultural identity should form the quality of the toponym and credibility of its attached map.

6 Conclusion

This case study shows heterogeneous ways of dealing with indigenous geographic naming by colonial powers in the process of exploration and mapping of Taiwan during the seventeenth to nineteenth centuries. Early Dutch and Chinese explorers were found to behave similarly by denoting Orchid Island with ambiguous names derived from external societies, simply illustrating a geo-referenced dot on the general maps of Taiwan. On the other hand, the Japanese explorers strove to insert names identifiable with local geography, functionally or culturally. These different naming strategies reflect not only colonial interests for ruling a foreign island, but also the cartographers' involvement with local society and their values of the local culture in defining a new geographic space. We intended to highlight in particular the human-inclusive way of mapping proposed by the Japanese ethnographers, who challenged the nature of cartography and geographic science as a tool in service of a political supremacy. How Japanese anthropology, as a new academic discipline rising from the late nineteenth century, influenced subsequent mapping and naming policies of indigenous lands in colonial Taiwan, is worth further research.

Finally, we remind readers that political powers continue to affect the contemporary mapping and geographic naming of indigenous islands. After World War II, Orchid Island underwent another wave of toponymic reform. The old Chinese name *Hungtou* was substituted by *Orchid* because of a stigmatized re-interpretation by the new government that "Red-Head Island gives an impression of some kind of red pest".[21] On the other hand, a few indigenous names were preserved 'by accident' because their written forms are in Japanese characters, and their meaning is not yet understood. We suggest that historical toponyms require a better understanding of their significance in map-making process and their influence on the constitution of geographic knowledge in world history.

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[21] According to the official document in 1947, Digital Japanese Ruling and Post-war Archive, Taiwan Historica 00301100008022.

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Petermann's Map of László Magyar's Travels in Angola: Its Sources, Compilation and Contents

Zs. Bartos-Elekes and Zs. Nemerkényi

Abstract This article is a further attempt by the authors to throw light on the cartography of the Hungarian explorer and traveller, László Magyar (1818–1864). In the mid-nineteenth century, Magyar was one of the first Europeans to travel extensively in central Africa in an area which today forms part of Angola. His reports on his travels were published in both Hungary and Germany. Magyar also compiled two manuscript maps, one in 1857 and one in 1858. In 1860 his 1858 manuscript map was used by August Petermann for an article and a map in*Petermann's Geographische Mitteilungen* (*PGM*) which reported on Magyar's travels. With the original map considered lost afterwards, the PGM map was the only authentic cartographic evidence of Magyar's travels in inner Angola for almost 150 years. In 2007, the question of what the 1858 manuscript map looked like, was solved when the authors found an exact copy of the map in the Cholnoky Map collection of the Babeş–Bolyai University of Cluj-Napoca in Romania (Nemerkényi, Bartos-Elekes 2012). In this article the authors report on their further research and their discovery in 2011 of a similar, but not identical, copy of Magyar's 1858 map in the Perthes Collection in Gotha. Using cartometric and qualitative methods, and the maps of travellers contemporary to Magyar such as Graça and Livingstone, they analyse the contents and speculate on the possible sources of the 1860 PGM map. They also highlight the relationship between the maps of Magyar, Graça and Livingstone, and the influence these maps exerted on the European cartography of central Africa of the time. For the benefit of the reader some of the illustrative material used in their previous article on Magyar's cartography is also included here.

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1 Introduction

In the mid-nineteenth century the German journal *Petermanns Geographische Mittheilungen* (PGM) was one of the most reputed geographical journals in Europe. With the eminent cartographer August Petermann as editor, PGM not only reported on the most important discoveries and mapping endeavours of the time, but also instigated, and sometimes even financially support, new geographical discoveries. For publication, only material which was considered "new" was accepted, and the publication of submitted manuscripts and maps was preceded by thorough professional control and editorial work. After publication, the original manuscripts were transferred to the archives of the publishing house with the result that the Perthes Archives today constitutes a primary source on the history of discoveries since the mid-nineteenth century.

In 1860 PGM published an article on the travels the Hungarian explorer, László Magyar, undertook during the 1850s in present-day central Angola (Magyar and Petermann 1860a). The article was accompanied by a map of the watershed between the Congo and the Zambezi Rivers, and was entitled (in German) *Original Map of László Magyar's Travels in Central Africa in 1850, 1851 and 1855.* Magyar's manuscript map which served as the main source for this published map, was considered lost until a manuscript copy, as well as the original, were found by the authors. The manuscript copy was discovered by chance in 2007 in the Cholnoky Map Collection of the University of Cluj-Napoca in Romania (Nemerkényi and Bartos-Elekes 2012). The original manuscript map by Magyar's own hand was found in the map collection of the Perthes Research Library at the University of Erfurt in Gotha, Germany in 2011.

The purpose of this article was, firstly, to investigate the most possible sources used for the compilation of the PGM-map and, secondly, to compare Magyar's map to contemporary maps in order to throw light on the editorial work which was carried out in Gotha. In the third instance we wanted to obtain a better idea of what was known in European scientific circles about inner Africa in the mid-nineteenth century. To achieve this, we expanded our research to also include the maps of David Livingstone and Joaquim Rodriguez Graça two explorers who mapped more or less the same territory as Magyar at approximately the same time. We posited as our basic hypothesis the assumption that the map published by PGM in 1860, was primarily based on the maps of Magyar, Livingstone and Graça. Using cartometric and qualitative analyses, we compared the maps of these explorers to find answers to questions such as: Did these authors make any measuring mistakes when compiling their maps? What were Magyar's and Graça's influence on Livingstone, and to what extent did the maps of these three authors influence the compilation of the PGM map? To what extent were their maps used in European publications, and what new information appeared on European maps after these explorers opened up the interior of south-central Africa?

2 Source Material for the PGM Map

The Portuguese explorer Joaquim Rodrigues Graça visited south-central Africa from 1843 to 1846. In 1856, as many as four years before Petermann published his article on Magyar, he published in PGM a report, accompanied by a map, on Graça's journeys and his visit to the drainage area of the Casai and Coanza Rivers (see Fig. 1). As no other nineteenth century map of this area had been published to date, Graça's map was the only cartographic information source on Angola for many years. Of the number of publications on Graça's journeys (Cooley 1856; Graça 1856, 1890; Graça and Petermann 1856; MacQueen 1856), the articles which appeared in PGM are the most important.

In 1854–1855 the well-known missionary-explorer David Livingstone crossed the interior of the country now known as Angola from Linyanti on the Zambezi river to Luanda on the west coast of Africa, and back (see Fig. 2). Keen on always reporting the newest information on African exploration, Petermann covered Livingstone's trans-Africa journey in PGM with an article and an accompanying map (Livingstone 1857). An interesting supposition of how Magyar's knowledge of Africa could have, and probably also did, assisted Livingstone in finding his way to Luanda, appears in the Hungarian-born author Listowel's book (1974), entitled *The Other Livingstone*.

Fig. 1 Graça's map published in PGM in 1856

Fig. 2 Livingstone's manuscript map of his journey from the Zambesi to Luanda 1854 (Copyright the Royal Geographical Society, London)

Like Graça and Livingstone, László Magyar was one of the first European explorers to travel in Angola. As the most detailed reports on Magyar's travels are published in Hungarian, studies on his explorations are limited. The most important to date are Gusztáv Thirring's classic book which appeared in 1937 (Thirring 1937); a recent Ph.D. thesis on Magyar's maps, providing also a contemporary bibliography on his travels (Nemerkényi 2008); a biography (Sebestyén 2008a), and an overview of Magyar's correspondence (Sebestyén 2008b). On the international front the list is even shorter with the only works known being those by Listowel (1974) and Vajkai (1997), in English, and Aparicio (1997), in Portuguese.

Judging by the evidence of his extant correspondence, Magyar completed three volumes and at least two manuscript maps. The first volume and its accompanying map date back to 1857, but only reached Europe in 1858 where they are still stored in the Manuscript Collection of the Hungarian Academy in Budapest (Magyar 1857). The remainder of his work (the greater part of the second volume, the third volume and his journals), could not be traced and are considered lost.

Magyar's first volume and his map of 1857 (see Fig. 3) describe the coastline and the western part of Angola. Magyar is mainly known in the international scientific literature for the geographical-ethnographical book which was based on his first volume and which was published in both Hungarian (Magyar 1859a) and German (Magyar 1859b). His 1857 map, which accompanied the book, was recently published in facsimile form in Hungary (Magyar 1993). What is peculiar about this map, is that it depicts the topographical detail of an area which is much larger than the narrow strips along which Magyar travelled. It remains an open

Fig. 3 Magyar's manuscript map of 1857 (Copyright the Hungarian Academy of Science, Budapest, and Cartographia Ltd., Budapest)

question where and how he obtained the topographical information to effect this with any degree of certainty as explorers of that time usually mapped only the narrow zones along which they travelled.

Magyar's second volume and the map which accompanied it, describe the unknown, inner part of Angola. In November 1858 he forwarded this volume, together with a map, to the geographer of the Hungarian Academy, János Hunfalvy. In 1859 Hunfalvy arranged for the manuscript to be published in Hungarian, albeit without the map (Magyar 1859c). Hunfalvy also forwarded the manuscript to Petermann, and in 1860 Magyar's text was published in German in PGM (Magyar and Petermann 1860a), this time accompanied by a map (Magyar and Petermann 1860b) compiled by Petermann (Fig. 4). Petermann did not publish the entire manuscript as Magyar's list of 200 words in the local African Moluva language was omitted .

The map Hunfalvy sent to Petermann in Gotha, was considered lost for almost 150 years. When Gusztáv Thirring wrote his book on Magyar in 1937, he mentioned that he, in 1892, had written to Petermann's successor, Alexander Supan, about the whereabouts of Magyar's 1858 map. Supan replied that the map was not at Gotha. Thirring's statement that he could not trace the map, can be justified from the letters he exchanged with Supan; the authors found these letters in Gotha. The authors found irrefutable evidence that the map was in the Perthes Archives

Fig. 4 The map of Magyar's travels published in PGM in 1860

for quite some time after 1860 as they came across a manuscript map of 1880 by a cartographer called Domann (1880), on which Magyar's travels are indicated. In 2011 cartographic history was again made when the authors found the map Hunfalvy had sent to Petermann (see Fig. 5) in the Perthes Research Library in a collection which was for a long time closed to the public during the communist regime in East Germany.

This map, which in the Perthes Collection is accompanied by Hunfalvy's letters to Petermann, has exactly the same title and content as the map that was discovered in the Cholnoky Map Collection in Cluj-Napoca in 2007 (see Fig. 6). Examining the two maps superficially, they appear to be identical, except for the handwriting which differs and which implies two authors. A comparison of the two maps was done taking into account different elements of the handwriting such as the formation of the letters, their sizes, loops and spacing, and the use of capital letters. After the scrutinizing their contents, it is evident that the handwriting on the map in the Perthes Collection is that of Magyar, whereas the map in the Cholnoky Collection is that of Hunfalvy, so he made a manuscript copy of the map before sending the original to Gotha. Cholnoky's autobiography contains a scant reference to the author having bought a manuscript map of Magyar from a second-hand bookshop and depositing and cataloguing it in the map collection of the University of Cluj (Géczi 1998: 216).

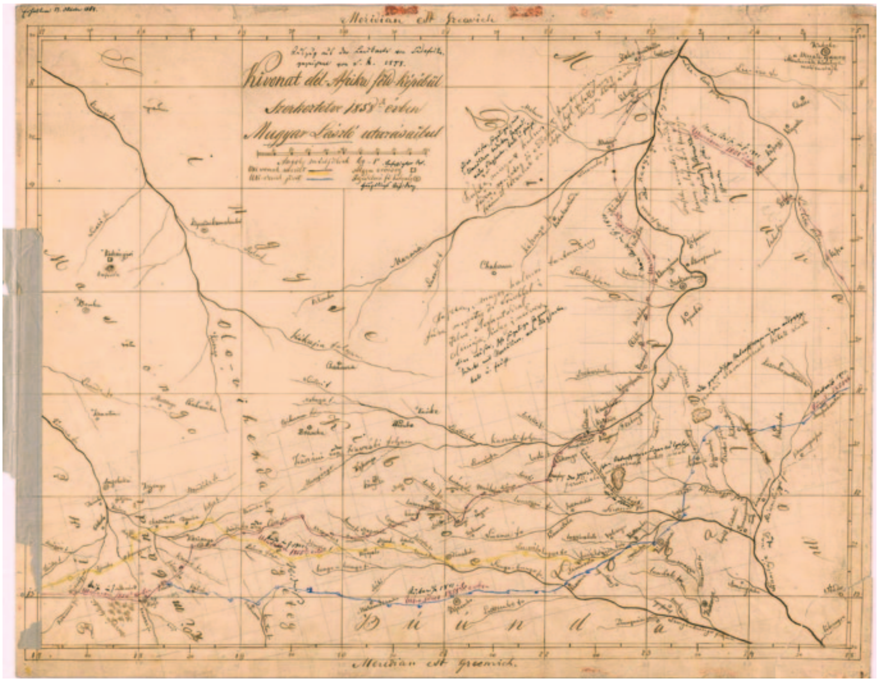

Fig. 5 Magyar's manuscript map of 1858 in the Perthes Collection (Copyright the Gotha Research Library, Perthes Collection, Gotha).

3 Compilation of the PGM Map

The editors of PGM were renowned for subjecting the travelogues and maps of explorers to a rigorous checking and editing process before publication. The Perthes Institute at that time boasted an extensive library, which meant that before publication, existing information would often be added to maps and obvious errors made by the cartographer(s), corrected. After adding some important information and often redesigning the map, the chief editor of PGM, August Petermann, was then considered the author of the new authentic, or *originalkarte*, and indicated as such on the printed map sheet.

The Perthes Collection of the Gotha Research Library possesses an important file containing Magyar's articles and maps (Sammlung Perthes SPA PGM 416). The same file also contains Hunfalvy's letters to Petermann. Between 1855 and 1860, Hunfalvy wrote 15 letters to Petermann, followed by another 2 in 1863 and 1870 respectively. The last two letters make no reference to Magyar. Hunfalvy's first letter to Petermann led to the first article on Magyar which was written by Hunfalvy himself and was published in PGM in 1856 (Hunfalvy 1856). Following this article, another seven based on Hunfalvy's information were published

Fig. 6 Hunfalvy's copy of Magyar's 1858 map in the Cholnoky Collection (Copyright the Babeş–Bolyai University, Cluj-Napoca and Cholnoky Geographical Society, Cluj-Napoca)

between 1856 and 1860. From Petermann's annotations on Hunfalvy's letters, it can be inferred that he only replied to four of the pre-1860 letters and to two of the later ones. In his notes on Magyar, Petermann often referred to the routes followed by Livingstone and Graça.

Two lithographed prints (one in Hungarian and one in German) of Magyar's first (1857) manuscript map also occur in the above mentioned file. Both maps depict notes made by the editors, with the geographical grid of the 1858 map transferred to the 1857 map. Magyar's 1858 manuscript map is attached to Hunfalvy's letter of October 1859. On this map, the only additions which originated in the editorial office seem to be the German translation of the original Hungarian annotations.

An important additional discovery in the Perthes Collection was the manuscript sketch map made by Hassenstein whilst he was preparing Magyar's 1858 map for publication in PGM (Sammlung Perthes, Kartensammlung 547-111800293). Bruno Hassenstein was at that time the chief cartographer of PGM and a dedicated follower of Petermann. It is evident from his sketch map that he modified the projection and the scale used by Magyar and also extended the territory covered by the explorer's map. On his geographical grid which covers a much larger area than Magyar's manuscript map, he not only indicates settlements, but also Livingstone's route from Linyanti to Luanda (see Fig. 7). Another interesting discovery in the Perthes Collection was some proof copies of the PGM-map (Sammlung Perthes 547-111757053, 547-111756529, 547-111757029) onto which the geographical grid of Graça's map had been transferred. A plausible explanation is that this helped Hassenstein to transfer some of the information around the Cuango River from Graça's map to both Magyar's and the PGM map.

4 Contents of the PGM Map

To adequately describe the contents of the PGM map, we firstly considered its planimetric (cartometric) accuracy and, secondly, examined the completeness of its contents by subjecting it to a qualitative analysis.

The first step, using *MapAnalyst* software, was to compare the available source maps of the three travellers (Magyar 1858; Graça and Petermann 1856; Livingstone 1854) to the 1860 map in PGM. By identifying the settlements which occur on both the source maps and the PGM map, we were able to form an idea of how much of the contents of the source maps actually features on Petermann's map. The *MapAnalyst* software generated the displacement vectors which highlight the spatial differences between the settlements on the two maps.

Fig. 7 An extract from Hassenstein's 1860 sketch map of Magyar's travels. (Copyright the Gotha Research Library, Perthes Collection, Gotha)

Magyar's manuscript map and the PGM map have the largest number of common indigenous settlements, namely 85. With some exceptions, every settlement which appears on the PGM maps also appears on Magyar's manuscript map. As most of the settlements had not been displayed on any other earlier map, their presence on Magyar's map was their first cartographic occurrence. Magyar was not necessarily the first European traveller who visited these places, but his map was the first of this area to be produced in such a detailed manner. It is evident from his map that he mainly travelled in a SW–NE direction in the area which forms the watershed between the Congo and the Zambezi Rivers. Along these routes, the displacement vectors generated by *MapAnalyst* are minimal, and the distortion grid is quadratic (see Fig. 8). This means that, as far as this area was concerned, the PGM 1860 map was mainly copied from Magyar's 1858 manuscript map. Points lying further away from these routes generated significant displacement vectors which indicate that the geographical information for these areas on the PGM map must have been acquired from other sources.

Graça's map and the 1860 PGM map show 26 settlements common to both maps. In the NW part of the PGM map the quadratic pattern of the distortion grid is apparent (see Fig. 9). As is indicated on Hassenstein's pilot-print, the PGM editors filled the empty spaces on Magyar's map with data taken from Graça's map. In the SW part of the PGM map, the settlements depicted by Graça were substituted with Magyar's settlements and toponyms. Although Graça's map also depicts settlements in this area, Magyar map was obviously considered more accurate.

In the 1850s several news bulletins and sketches depicting Livingstone's route from the Zambesi to Luanda appeared in PGM and other journals such as the *Journal of the Royal Geographical Society*. When we compared Livingstone's original manuscript map of 1854 with the PGM map (see Fig. 10), we found only 11 settlements which appear on both maps. Based on this comparison, we inferred that the PGM map is more detailed than Livingstone's, but that the editors considered it important to depict Livingstone's route so as to be able to compare it what that of Magyar.

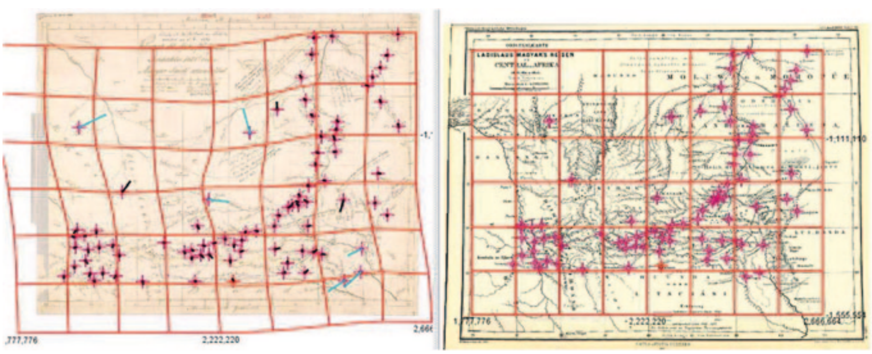

Fig. 8 Magyar's 1858 map (*left*) compared to the PGM map (*right*), showing common settlements, displacements and distortions

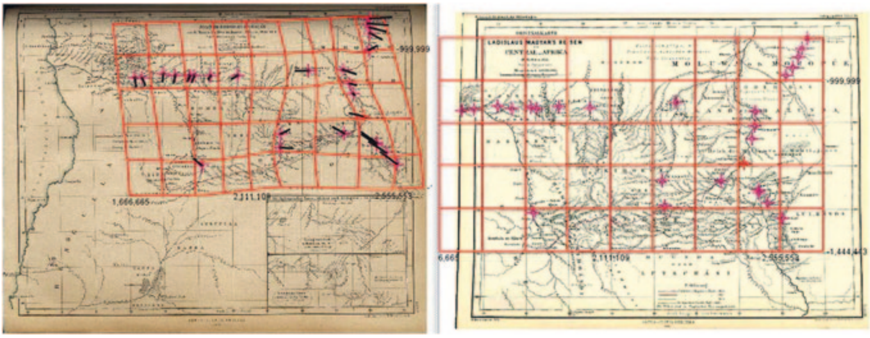

Fig. 9 Graça's map (*left*) compared to the PGM map (*right*), showing common settlements, displacements and distortions

To analyse the completeness of the content of the PGM map, we used *Global Mapper* software and a modern hydrography database to compare the hydrographic pattern on Gracas' map with that on Magyar's 1860 manuscript map. We found that the two maps are almost 80 % similar, although a more thorough analysis revealed that Magyar's map is more detailed and precise. The major differences are referred to below.

The area where the Zambesi originates was not mapped by Graça, but was depicted by Magyar. Graça only indicated the Liba (or Londa) stream, whereas Magyar also mapped the Lungue-Bungo which suggests a more detailed survey. Magyar also depicted the Mazara River, a feature Petermann copied from him without proof. Another error on Magyar's map which seems to have been blindly copied by Petermann, is the mouth of the Cassai River which Magyar apparently confused with one of its left tributaries. As Magyar never visited the area west of

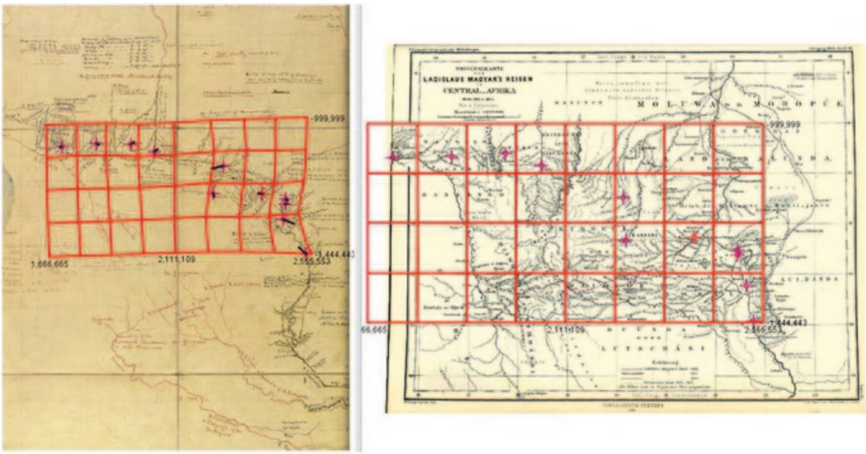

Fig. 10 Livingstone's map (*left*) compared to the PGM map (*right*), showing settlements common to both maps with displacements

the Cassai, his depiction of the upper segment of the river was done from hearsay. This defect was apparently also adopted by August Petermann as this section of the river on the PGM map does not resemble any known river on a modern map. Although the Cubango and Coanza Rivers in the south western part of the PGM map were not correctly indicated by Graça, their overall placement on his map is more correct than on Magyar's 1857 map.

Lake Dilolo was indicated by Graça, but not by Magyar. Graça's map depicts the position of the Lake correctly, whereas Magyar only shows a swamp with no name. Slightly further east, Magyar also indicates another water surface, again with no name but accompanied by a lengthy annotation. It is interesting that the PGM map also calls this feature the Dilolo See, but retained the swamps, as the editors probably failed to decide which source to accept as more authentic.

The most significant differences between the two maps can be seen in the NE part of the PGM map which borders on the settlement known as Yah Quilem (not in the map). Yah Quilem was the center of a powerful, widely known, and feared ruler. Magyar claims to be the first European to visit Yah Quilem, a statement which might not be true, although he might have been the first to map this area in detail. Magyar also knew that Livingstone was wrong when he appropriated certain rivers such as the Cassai to the catchment area of the Zambezi. According to Thirring, Magyar was the first to realise that the Cassai belongs to the catchment area of the Congo, and flows to the Atlantic, and not the Indian Ocean (Thirring 1937: 148).

The above observations led to important conclusions which helped us to explain the measurement inaccuracies and mistakes on all three maps. What also helped, were the archival sources which provide the exact chronological order of the journeys of the three travellers. Magyar was the last of the three explorers to visit this territory. Still, his maps provide the most accurate hydrographic descriptions. There is, however, a common mistake which can be detected on Magyar's map. On his map, the error in longitude is more pronounced, as determining longitude (measuring the time), was more complicated than determining latitude (measuring the angle). Based on Magyar's writings we can suppose that he did not conduct measurements using surveying equipment to define his geographical position. (Magyar 1859a: 461) In spite of this, his 1858 map gives a surprisingly accurate view of the river network characterising the watershed between the Congo and the Zaire.

5 Conclusion

Magyar's 1858 map of inner Angola was more detailed than the maps of his predecessors and depicts the topographic features of the watersheds between the great African rivers such as the Congo and the Zaire surprisingly accurate. When Hunfalvy submitted this map to PGM for publication, both Petermann and Hassenstein realised its importance.

When compiling their own map of present-day central Angola, Petermann and Hassenstein used maps showing the routes of all three explorers, i.e. Graça, Livingstone and Magyar. For the southwestern part of the map (the Kingdom of Bié), they relied on the data provided by Graça and Magyar, obviously favouring the latter. For the northwestern section comprising the drainage areas of the Cuanza and Cuango Rivers, they preferred the positions provided by Graça and the toponyms provided by both Magyar and Graça. For the southeastern part of the map (the Lungué-Bungo and Zambezi drainage areas), they mostly depended on Magyar and Livingstone. For the northeastern section (Cassai) Magyar's map was the only source. Magyar's map therefore served as a link between Graça's and Livingstone's maps and acted as the only source of reference for the northeastern section of the mapped area. Given the dearth of reliable maps of this area, Magyar's map maintained this position for many years.

When compiling his own map of the area straddling the borders of the present-day Angola. Zambia and the Democratic Republic of the Congo in 1860, Petermann freely made use of Magyar's map. In doing this, he acknowledged the fact that this map was more accurate than any earlier map of this part of the continent. At the time, Magyar's explorations in Africa were considered important in leading scientific circles in Europe, and the 1860 PGM map further strengthened this notion. Like the explorations of Graça and Livingstone, his travels significantly helped to fill the white spaces which characterized European maps of Africa of the mid-nineteenth century.

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The "Major Jackson's Transvaal and Natal Series" of the Anglo-Boer War (1899–1902): A Cartobibliographic Framework

Elri Liebenberg

Abstract The Anglo Boer War (also known as the South African War) was fought between the two Boer Republics (the South African Republic or Transvaal, and the Orange Free State) and the British Empire from October 1899 until May 1902. Soon after Pretoria was occupied by British forces in June 1900, the Head of Topography of the local Field Intelligence Department, Major H.M. Jackson, commenced with the compilation of a map of the South African Republic and Natal to supersede the inadequate IDWO 1367 and *Imperial Map.* This new map, known as the Major Jackson's or First Transvaal Series, was compiled on a scale of 1:148,752 (1,000 Cape roods or 2.34 miles per inch) and covered the whole of the Transvaal Republic, northern Natal, Zululand and Swaziland, and the western part of British Bechuanaland. Cartographically it is a fine example of a compilation map executed *de novo* for military purposes under conditions of extreme urgency in a foreign area devoid of a trigonometrical base. The compilation was done from available farm and mining surveys as corrected and supplemented by information gathered by the No 1. Survey Section which was sent to South Africa by the War Office, and various officers in the field. The method of reproduction used was lithography, and subsequently photolithography. By December 1900 the whole series was completed and during the ensuing months most of the sheets were repeatedly revised, many as much as up to six or seven times. Initiated to serve urgent military demands, the publication of the series was discontinued after the cessation of hostilities. This paper documents the progress of the survey, compilation and reproduction of the Major Jackson's Series by using surviving maps and other archival material in South Africa and the UK.

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1 Introduction

The Major Jackson's series was one of a number of map series produced by the British forces during the War. The maps took their name from Major Hugh Milbourne Jackson, RE who served in South Africa as Head of Topography for the Field Intelligence Department and acted as Surveyor General of the Transvaal Colony from 1902 to 1905 (Fig. 1). Historically the series is of interest as it represents the maps most commonly used in combat situations. Cartographically the series represents a type of map which was produced in Africa during the late nineteenth and early twentieth centuries in areas where no trigonometric control system existed. To fully understand the provenance and significance of the Major Jackson's series, it is necessary to first consider the context within which the maps originated.

By 1899 South Africa was, as far as large-scale mapping was concerned, still unmapped. Although the Orange Free State and the Transvaal each had a Surveyor General since 1876 and 1866 respectively, these officers dealt solely with cadastral matters. Surveyors General of the two Republics had no tradition of topographical mapping and made no concerted effort to obtain large-scale maps of their countries.

Fig. 1 Major HM Jackson (1858–1940)

With the exception of a few small-scale maps compiled before the war by a number of government officials for administrative purposes, the Boer forces entered the war without any significant official maps or cartographic material. Indeed, it was reported that some of the maps compiled by the British were reproduced by the Boers for their own use (Royal Commission 1903, Report Cd 1789: 160; Royal Commission 1903, Report Cd 1790: §712–30, §4994–5019, §10615–1062).

When war was declared, the Cape had been a British colony since 1804 and Natal since 1848. During this period Britain did not undertake any large-scale mapping of the interior with the result that by 1899 the available maps were "with perhaps one exception, very incomplete and unreliable" (Royal Commission 1903, Report Cd 1789: §261). The reason for this was that the surveying and mapping of all self-governing colonies was regarded by the Imperial Government as a domestic matter to be catered for by the colonial governments themselves. The colonies were expected to finance their surveys out of current revenue and to produce their own maps. The fact that many survey departments were ill-provisioned and understaffed, and that colonies did not regard detailed topographical maps for military purposes a necessity in the earlier stages of their development, were not taken into account. Neither was it considered that many colonies might not have felt under an obligation to provide for the military necessities of the Empire (Amery 1909: 350).

2 Mapping Before the War

During the period immediately preceding the war, the state of tension between Britain and the two republics made it impossible for British intelligence officers to undertake any surveying and mapping in either the Orange Free State or the Transvaal. The best Britain could do was to produce so-called "compilation maps" from whatever survey, cartographic and topographical material were available and to supplement these with sketches and traverses from various sources such as boundary, mining and railway surveys, military reports and reconnaissance surveys, as well as the oral accounts of transport drivers and commercial travellers. In 1903 the Royal Commission on the War noted: "The [Intelligence] Department was in possession, during the period 1896–1899, of all map material of all parts of South Africa affected by the war, which was known to exist, either in the shape of published maps and sketches, unpublished surveys and plans, and MS work. Every attention was given to the compilation of this information into map form" (Royal Commission 1903 , Report Cd 1789: p. 160).

The first compilation map produced by Britain was the 28-sheet IDWO 1367, *Transvaal and the Orange Free State* on a scale of 1:250,000 which was published at the advent of the war in 1899 (see Fig. 2). The compilation took place at the War Office under the supervision of Major SCN Grant, RE. The maps depicted railway lines, wagon roads and tracks, the drifts over rivers and streams, some important place names and the most important watering places. No farm boundaries or farm names are shown as the British Intelligence Service had at that stage

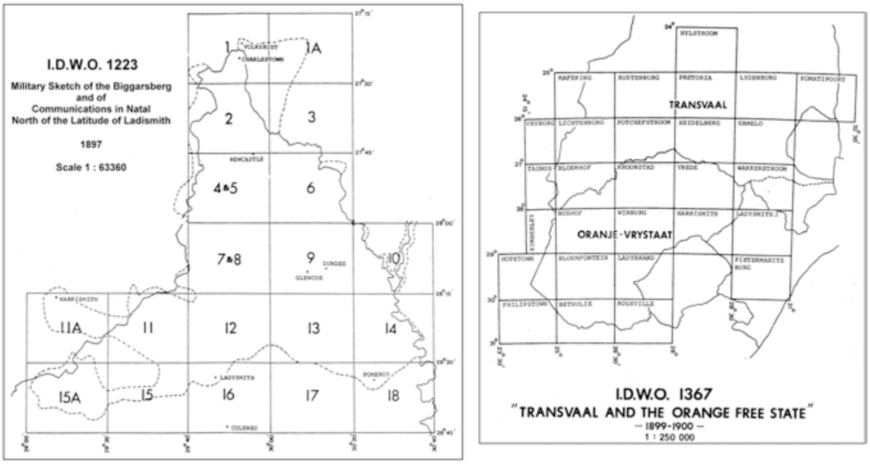

Fig. 2 Key maps of *IDWO 1223* of Northern Natal and *GSGS 1367* of the Transvaal and Orange Free State

no access to the existing cadastral information of the two Boer republics. The relief features are sketchily depicted by means of hachures.

As Natal was a British Colony, the railway line from Durban to the Witwatersrand, which runs through northern Natal, was of great strategic importance. Britain had not forgotten the defeat it suffered at Amajuba in February 1881 during the First War of Independence against the Transvaal, and already in 1896, half a mapping section under Major SCN Grant, RE was sent to Natal where it was used for compiling a military sketch map (IDWO 1223) on a scale of 1:63,360 of the area to the north of Ladysmith (see Fig. 2). The maps were not suitable for strategic purposes, but far better than any other map that was available at the time.

3 Organisation of Survey and Mapping

The British national mapping organization, the Ordnance Survey, was founded in 1791 and by the end of the nineteenth century the British Army already had a proud tradition of scientific survey and mapping. By this time it was also generally accepted that maps were indispensable in a situation of war. The result was that the Ordnance Survey was also in charge of the Intelligence Department of the War Office. Military surveyors serving in the British army belonged to the corps of Royal Engineers and all maps of overseas areas published during this period were issued under the serial number IDWO, designating the Intelligence Department, War Office. A unique IDWO number was allocated to each map in the order in which it was issued. Maps printed and issued in South Africa by the local Field Intelligence Department during the war were designated FID.

When the war commenced, Britain immediately took steps to try and remedy the shortage of suitable campaign maps by despatching survey and mapping sections to South Africa to serve under the Director of Military Intelligence. A survey section normally consisted of an officer and six to eight specially trained non-commissioned officers and men, while a mapping section consisted of one officer and between five and ten non-commissioned officers and men. In some cases civilian draughtsmen and surveyors were also attached to a mapping section. A survey section normally carried out the actual surveying work, while a mapping section compiled maps based on either the work of the survey section, or on other available sources. The mapping sections were also responsible for editing, printing and issuing the final maps. This division of work was not always rigidly adhered to during the war as survey sections frequently functioned as mapping sections, and *vice versa* (Amery 1909: 351–2).

The No 1 Survey Section under the command of Captain CF Close, RE arrived in Cape Town on 3 February 1900, whereas the No 2 Survey Section (under the command of Captain PH du P Casgrain, RE), arrived in South Africa in April 1900. The mapping sections which were eventually stationed at Pretoria, Bloemfontein and Cape Town, had their origins in two "half" mapping sections. The first "half" section, under Major SCN Grant, RE, which based itself in Natal in 1896, has already been referred to. The second "half", commanded by Major HM Jackson, RE, arrived in Cape Town in November 1899. After producing valuable route sketches and reconnaissance work in the Cape Town area, Jackson joined the Third Army Division at Sterkstroom in the north-eastern Cape Colony. When Field-Marshall Roberts began to advance on the Orange Free State and Transvaal from Cape Town in February 1900, Jackson, who had in the mean time been recalled to Cape Town, joined the main force. The No 1 Survey Section under Close which had been working in the Northern Cape, also accompanied Robert's ranks and, together with Jackson, undertook valuable survey and mapping work along the Cape-Kimberley railway line. In April 1900 Jackson's Mapping Section joined Close's Survey Section and the main force at Bloemfontein and together the two sections did some surveying and mapping there and at Kroonstad. When Close contracted enteric fever and was invalided back to England, Jackson took over the command of No 1 Survey Section and escorted the combined Sections to Pretoria (Watson (reprinted 1954): 191–192; Jackson and Casgrain 1903: 10–11).

4 Early Mapping During the War: The Imperial Map

Once the war was underway and the Orange Free State and the Transvaal occupied by British forces, it was the Offices of the respective Surveyors-General which yielded the most information for mapping purposes. Similar to their counterparts in the Cape Colony and Natal, the Surveyors General of the Orange Free State and the Transvaal had built up a considerable body of cadastral information since their inception. The title diagrams filed with them were the most authoritative cartographic source material available and once the governments of the two republics were taken over by the invading forces, these diagrams were fitted together like the pieces of a jig-saw puzzle into makeshift compilation maps.

In March 1899 an agreement was entered into between the mapping branch of the Field Intelligence Department in Cape Town and a surveying firm, Messrs JT Wood and AA Ortlepp, for the production of a compilation map of the Transvaal and Orange Free State (Fig. 3). This map series was known as the *Imperial Map of South Africa* and was compiled hastily from a variety of sources. In January 1901 Major PH du P Casgrain who was in charge of the No 2 Survey Section and mapping section in Cape Town, took over from Messrs. Wood and Ortlepp and proceeded with the compilation of the *Imperial Map of the Cape Colony* on the same scale. Although an improvement on IDWO 1367, the Imperial Maps were also inaccurate and their crude representation of the hydrological and relief features made them unsuitable for strategic planning purposes. Their main merit was that they showed farm boundaries and provided the map user with a vast number of place names (Board 2004).

Fig. 3 Imperial map of South Africa

5 Major Jackson’s Transvaal and Natal Series

Soon after Pretoria was occupied in June 1900, Jackson was appointed Head of the Topographical Branch of the Field Intelligence Department (FID). Realising that the *IDWO 1367* as well as the Imperial Map series were inadequate for war purposes, he decided to compile a new series on a scale of 1:148,752 (1,000 Cape roods or 2.34 miles per inch) which would cover the whole of the Transvaal, the northern part of Natal, Zululand, Swaziland, and the part of Bechuanaland bordering onto the Transvaal. The compilation would be done by the Mapping Section stationed in Pretoria from the farm and mining surveys of the South African Republic and Natal as corrected and supplemented by information gathered by the No 1. Survey Section and various military officers in the field.

Jackson’s map series, also known as the First Transvaal Series, was initially designed to consist of 62 sheets of irregular size (see Fig. 4). Sheet no. 58 (Olifant’s River) was never issued, and 10 sheets (38 B to 38 M) covering southern

Fig. 4 Key map of “Jackson’s Transvaal” published by the FID in 1901

Natal were later added which brought the total to 71. The two sheets straddling the Limpopo River in the extreme north (nos. 29 and 29A) which appear on some later Key Maps were also not issued.

The sheet lines were not fixed according to the geographical grid but presumably followed the Cassini-Soldner 'spheroidal rectangular' projection. The Cassini-Soldner system was used by both the South African Geodetic Survey of the Cape Colony and Natal (1883–1892), and the Natal Secondary Triangulation undertaken by August Hammar during the last decade of the nineteenth century (Simpson 1989: 116; Mugnier 2012: 913). No lines of latitude and longitude appear on the Jackson maps and if it was not for the small Key Map in the margin, it would have been difficult for the user to know where a specific sheet fitted into the overall picture.

5.1 Compilation

The British forces had suffered heavy defeats in December 1899 and January 1900 and providing reliable maps to the field forces was a matter of the utmost priority. Compilation on the First Transvaal Series started as early as June 1900 and was diligently pursued until February 1901 when the last sheet was completed. With the exception of the Natal, sheets and maps which bordered on Natal and neighbouring states such as the Orange Free State, Swaziland and British Bechuanaland, all maps were compiled from farm surveys in the Office of the Surveyor General of the Transvaal. The Natal sheets were compiled in Pietermaritzburg by the Surveyor General of Natal and, where necessary, the cadastral information pertaining to the Orange Free State was provided by the Surveyor General in Bloemfontein.

As the farm surveys were of variable quality (see Fig. 5), the maps had no pretence to be accurate. Many sheets carry a notice that all heights except those of railway levels are inaccurate, as well as a warning that "143 feet should be subtracted from all heights in this sheet". The reason for this systematic error is unclear. Relief features were transferred from survey diagrams and as the accuracy and quality of the latter depended entirely on the ability and artistry of the surveyor who originally performed the survey, this information was often sketchy and in many cases incomplete (see Fig. 6).

After inspecting the relevant diagrams, the best the compilers could do was to depict the actual and supposed relief features by means of form lines. Areas that had not been surveyed prior to compilation were left blank (see Fig. 7) and in many cases the formline patterns were left incomplete (see Fig. 8). Several maps also mention that farm boundaries shown by broken (pecked) lines are from inspection plans which are not reliable. After the war Jackson wrote of this exercise: "… maps so prepared, not based on any topographic survey, must always include much information of unequal or doubtful value, even if it is not positively misleading. The best that can be said of them is that they were issued *faute de mieux*, and that the utmost was done with the means at disposal to improve them" (Jackson 1906: 276).

Fig. 5 Example of a survey diagram used for compilation

The survey diagrams which were used for the map sheets of northern Natal and Zululand were supplied by the Surveyor General of Natal. Compilers working on the Natal sheets and those which straddled the Transvaal-Natal border also made use of Grant’s 1896 survey of northern Natal. In the case of Swaziland, information was gleaned from boundary surveys and Miller’s sketch map of Swaziland (Masson 1989). Alistair Miller was a journalist and businessman who lived in Swaziland and served as an Intelligence officer with the British forces during the war. For map sheets bordering on British Bechuanaland, information was obtained from the relevant Surveyor General.

Although they were more involved with the revision of the First Transvaal Series, once the maps were published, the No 1 Survey Section initially also contributed to the compilation of the maps. On their arrival in Pretoria in June 1900, they carried out a topographical survey on a scale of 2 inches to 1 mile of an area of about 180 square miles around Pretoria. The resultant map was printed and the survey results used in the compilation of the Pretoria sheet (sheet no. 1 in Fig. 4).

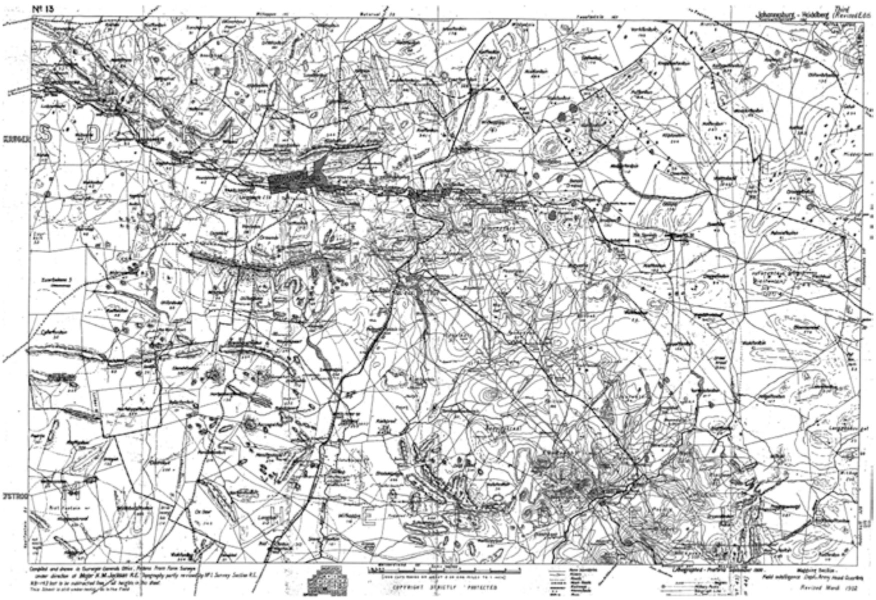

Fig. 6 Sheet 13 (Johannesburg-Heidelberg)

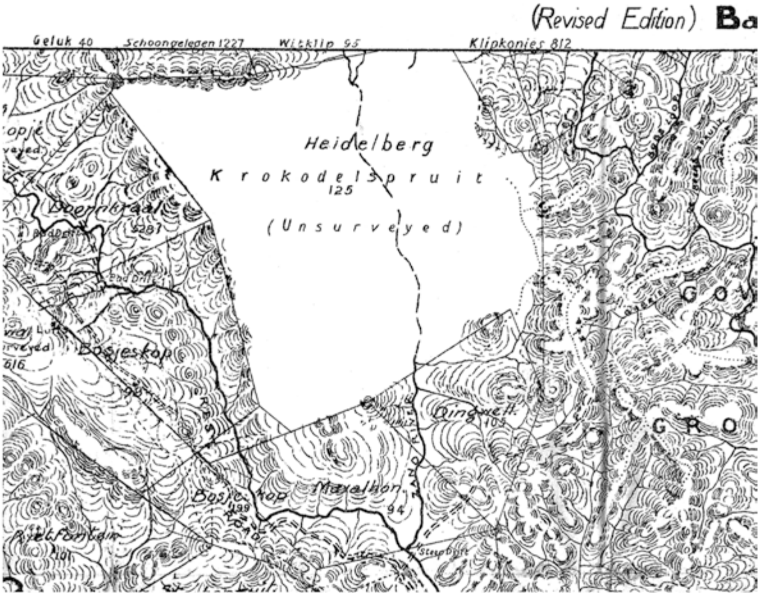

Fig. 7 Detail from sheet 8 (Barberton)

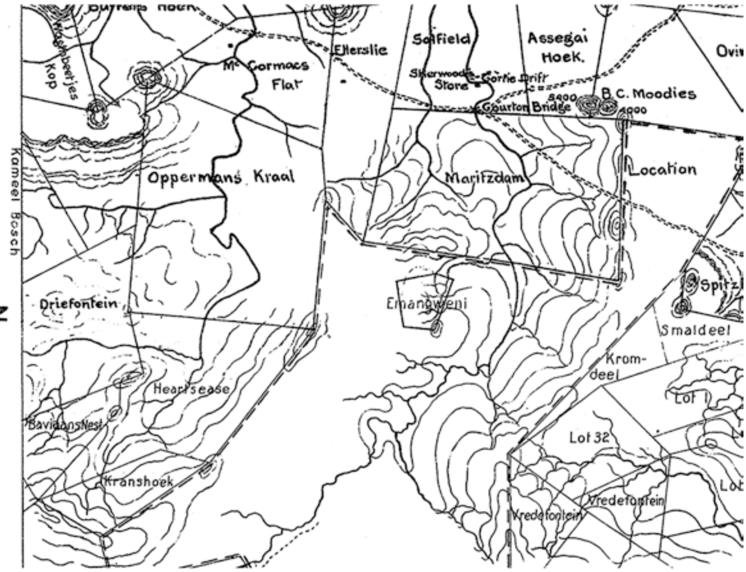

Fig. 8 Detail from sheet 38A (Ladysmith)

A local map which was of inestimable value during the compilation process was Jeppe’s map of the Transvaal of 1899 on a scale of 1:476,000 (Carruthers 2003) (see Fig. 9). Friedrich Jeppe was a German immigrant who became Postmaster General of the Transvaal and later worked as Chief Draughtsman in the Office of the Surveyor General. He was a pioneer cartographer and in his private capacity published the first map of the Transvaal in 1868. His map of 1899 was published in Switzerland and confiscated by the British who considered it the best map of the South African Republic at the time. That Jeppe’s 1899 map would be consulted was logical as it was the only map to date which depicted cadastral information as well as relief.

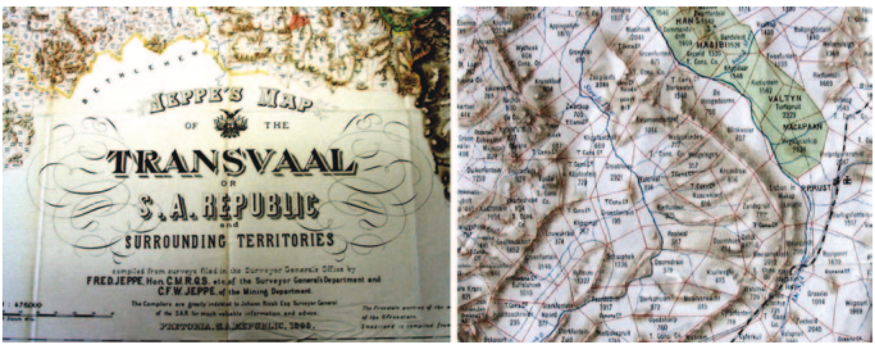

Fig. 9 Detail from sheets 4 and 5 of Jeppe’s 1899 map

By December 1900 the compilation of the Transvaal sheets of the Major Jackson's series was completed. The compilation of the Natal sheets which depended on farm surveys provided by the Surveyor General of Natal, lagged behind, but was finalised by May 1901. From the small Key Maps printed in the margins of the Transvaal sheets and a Key Map published by the FID in May 1901 (see Fig. 4), it can be inferred that Jackson's initial idea was to map only the northern part of Natal. Further evidence of this decision is that the First Edition of the Ladysmith sheet (no. 38A) which was published in July 1901 only covered Natal as far south as Estcourt (29° South). However, a Key Map printed by the end of the war (see Fig. 10), shows that Natal was eventually covered in its entirety—the maps of the northern area compiled by Major Jackson in Pretoria, and those of southern Natal by the Surveyor General of Natal in Pietermaritzburg. On the revised Ladysmith sheet issued in February 1902, the country south of Estcourt had been visibly added to the mapped area.

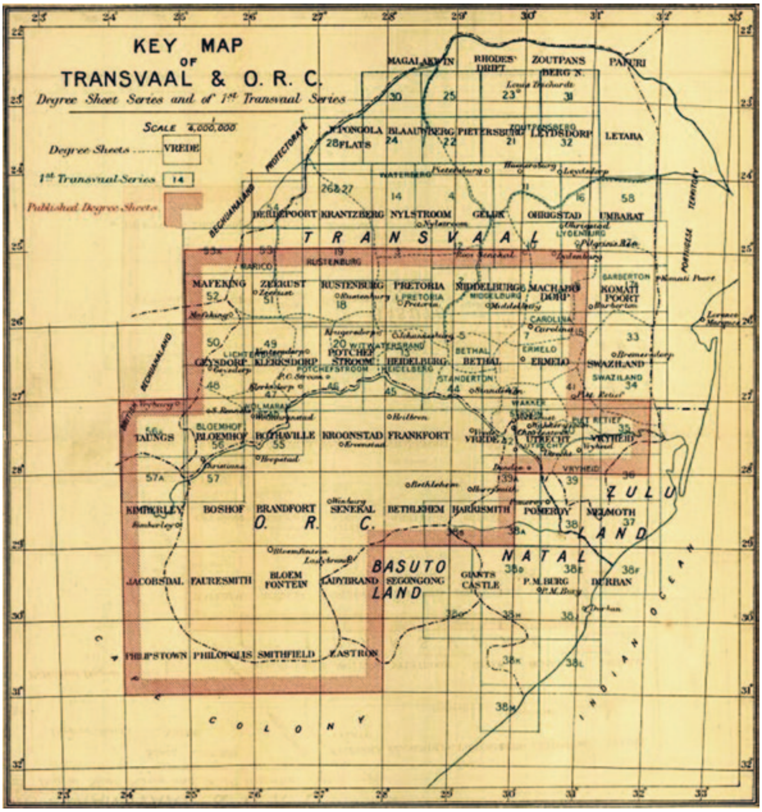

Fig. 10 Key map published after the war

5.2 Reproduction

The first sheets were published in July 1900 and by the end of that year 21 sheets were published (see Fig. 12). In 1900 the war north of the Vaal River was mainly fought towards the Eastern and Northern Transvaal and the sheets which were printed were those which pertained to the Pretoria-Johannesburg area, as well as the maps which depicted the railway lines to Delagoa Bay and Durban, and the main road northwards to Rhodesia.

The maps which were issued until January/February 1901 were reproduced by lithographic means, i.e. the compilation was transferred to a lithographic stone and from there directly printed onto paper. After February 1901 the preferred method of reproduction was photolithography, and later photozincography, which made provision for the transfer of the compilation onto a lithographic stone or a metal plate by means of a photographic process. All maps were printed in monochrome. During the early stages of the War, thick linen-backed paper was used but, as supplies ran out, more inferior paper types had to be used (Jackson 1900: 10). The map sheets were then folded into pocket or booklet size in such a way that large areas could be read without completely unfolding the map (see Fig. 11).

Although the maps of the First Transvaal Series were all printed in Pretoria, No 1 Survey Section also made use of printing facilities which could be operated in the field (see Figs. 13 and 14). This equipment was used throughout the war to produce maps and sketches which in all probability assisted with the checking and revision of the Transvaal maps (Jackson and Casgrain 1903: 23–24; Jackson 1906: 283–284).

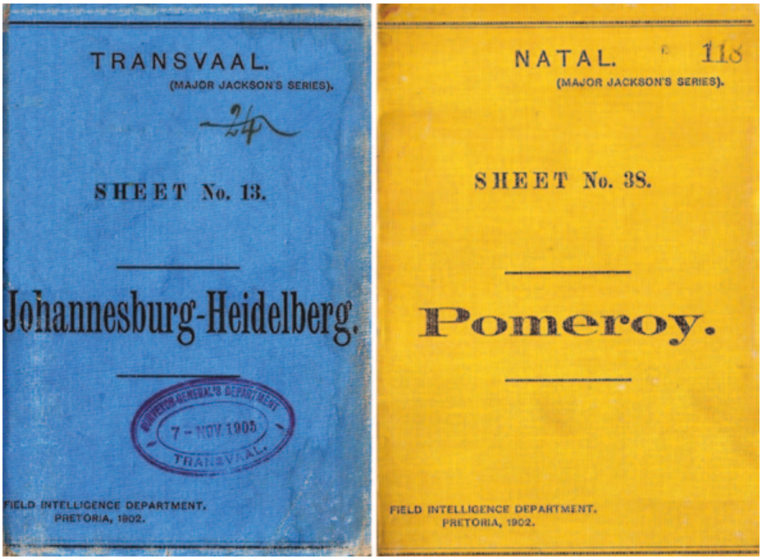

Fig. 11 Examples of maps folded in booklet form

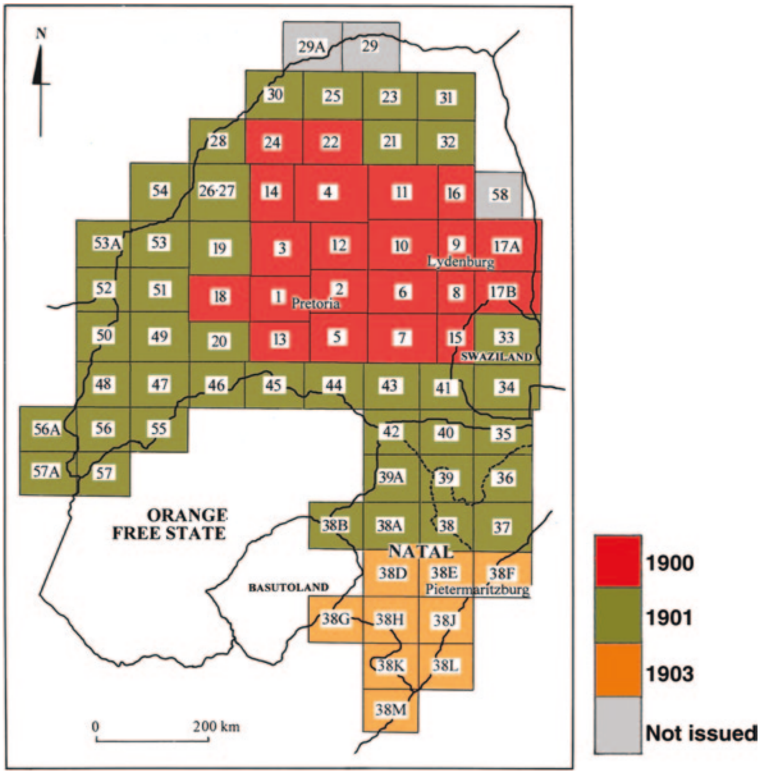

Fig. 12 Publication of first editions

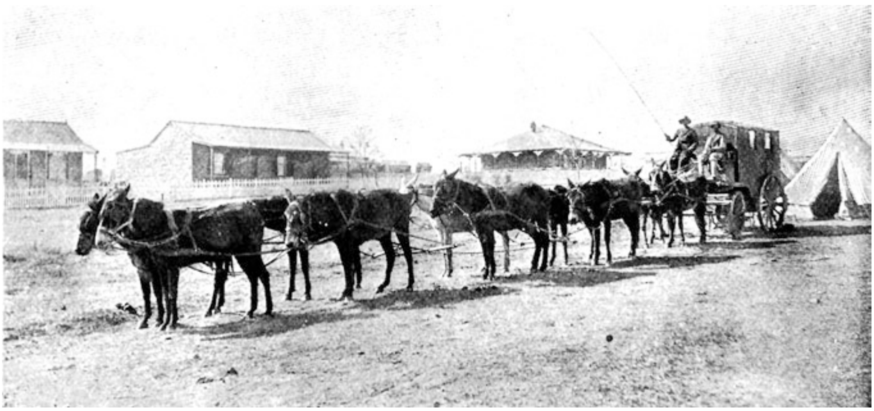

Fig. 13 Mule wagon used to transport survey and mapping equipment

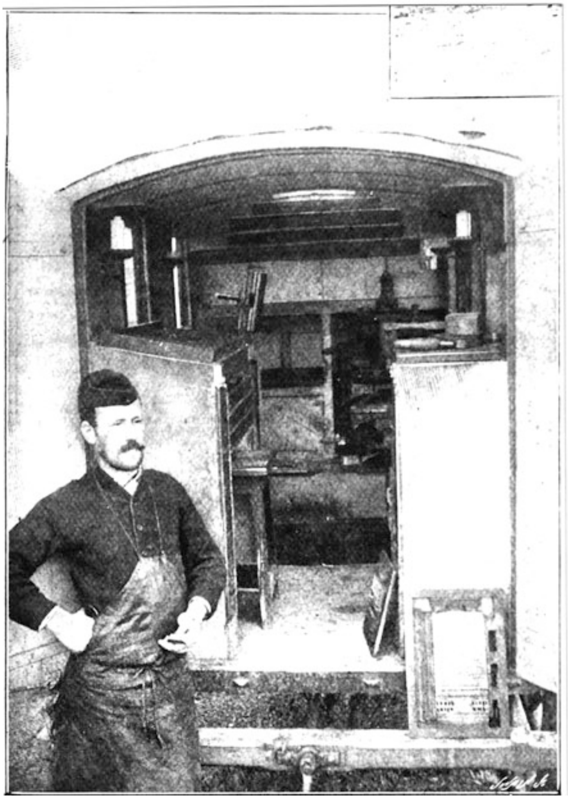

Fig. 14 Custom-made wagon used to lithographically print maps in the field

5.3 Lettering and Symbolization

The lettering on the maps was done manually and therefore varies from one sheet to the next. On many maps different hands can be detected as the map passed from one edition to the next.

The Anglo Boer War was a war fought on horseback and one would have expected Jackson’s maps to acknowledge this fact. Later maps published by the War Office indicate for instance types of grazing, the provision of water, the availability of firewood, the locations where rivers and streams were fordable on horseback, etc. (Liebenberg 1997; Board 2009). Jackson’s maps are, however, devoid of such special features and the conventional signs depicted are the same as those which could be expected on any topographical map (see Fig. 15).

5.4 Revision

The first sheets of the Major Jackson’s Series were published long before the compilation of the entire series was completed whilst the revision of existing sheets

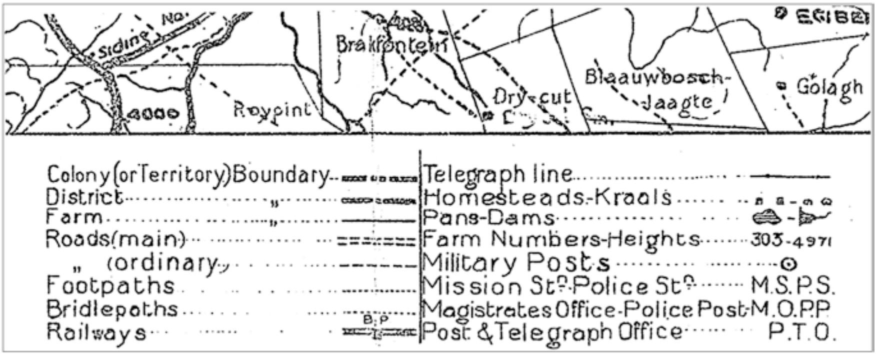

Fig. 15 Legend used on all maps sheets

had already begun in February 1901. A situation which contributed to this was that by December 1900 survey work in the field became almost impossible due to the presence of Boer forces. As the demand for compiled maps was increasing by the day, Jackson decided to put a stop to field surveys and rather apply the services of the No 1 Survey Section towards the compilation of outstanding sheets and in the revision of the existing ones (Jackson and Casgrain 1903: 11). The continuous revision of the series was performed diligently until the cessation of hostilities in May 1902.

By May 1901 the situation in a large part of the Transvaal had improved to such an extent that surveyors could be sent into the field once again. The result was that approximately 3,000 square miles of reliable topographical survey could be performed and the results incorporated into new sheets (Jackson and Casgrain 1903: 11). That the topography on the ground was partly revised by the No 1 Survey Section, is acknowledged in the margin of the following sheets: No.1 (Pretoria), No. 20 (Ventersdorp), No. 47 (Klerksdorp), No. 55 (Wolmaransstad) and No. 56A (Taungs).

Revision also took place after the accuracy of maps had been tested in combat situations and omissions or errors reported to the Field Intelligence Department. Many sheets passed through as many as six or even seven editions with each edition being a slightly corrected and updated reprint of the previous one. Compiling a list of the various editions (see Table 1) was problematic as the various sheets do not mention which editions they represent, but merely depict a date such as September 1901 on which the sheet was revised. In order to trace the number of revisions which might have preceded this date, the sheet in question had to be compared to the same sheet in as many other collections as possible (see Fig. 16).

For the purposes of this article, the map collections of the following institutions (with the number of sheets in brackets) were researched: National Archives of South Africa (99); National Library of South Africa (Pretoria) (109); Cullen Library, University of the Witwatersrand, Johannesburg (33); Merensky Library, University of Pretoria (57); Chief-Directorate of National Geo-Spatial Information, Cape Town (64); British Library, London (12); Royal Geographical Society, London (67); and the Bodleian Library, University of Oxford (62).

Table 1 The Major Jackson's series: dates of compilation, publication and revision of sheets

Sheet no and name		Comp	Publ	1st Rev	2nd Rev	3rd Rev	4th Rev	5th rev	6th rev	7th rev
1	Pretoria	Jun-00	Aug-00	Apr-01	Sep-01	Apr-02	Jun-02			
2	Pretoria-Middelburg	Jun-00	Aug-00	Apr-01	Jun-01	Aug-01	Sep-01	Jan-02	Mar-02	
3	Hartingsburg (Warm Baths)	Jun-00	Sep-00	Apr-01	May-01	Jul-01	Nov-01	Mar-02	May-02	Jun-02
4	Nylstroom-Pietersburg	Jul-00	Jul-00	Jul-01	Nov-01	Jul-02				
5	Bethal	Jun-00	Sep-00	Feb-01	Apr-01	Jul-01	Sep-01	Nov-01	Feb-02	Jun-02
6	Belfast, Machadodorp, Dullstroom	Jun-00	Jul-00	Feb-01	May-01	Dec-01	Jan-02	Feb-02		
7	Ermelo-Carolina	Jul-00	Aug-00	Apr-01	Jul-01	Sep-01	Nov-01	Feb-02		
8	Barberton	Jul-00	Aug-00	Jul-01	Nov-01	Feb-02	Apr-02	May-02	Jun-02	
9	Ohrigstad-Pilgrimsrest	Jul-00	Aug-00	Jul-01	Nov-01	May-02	Jun-02			
10	Lydenburg	Aug-00	Aug-00	Jul-01	Nov-01	Feb-02	Jun-02			
11	Leydsdorp	Aug-00	Sep-00	Apr-01	Jun-01	Oct-01				
12	Springbok flats (Bluidefontein)	Aug-00	Aug-00	Feb-01	Jul-01	Sep-01	Feb-02			
13	Johannesburg-Heidelberg	No dates	Sep-00	Apr-01	Oct-01	Mar-02				
14	New Belgium Sand River Poort	Aug-00	Sep-00	Jun-01	Oct-01	Mar-02				
15	Steynsdorp	Jul-00	Aug-00	May-01	Sep-01	Feb-02	Apr-02	May-02	Jun-02	
16	Selati	Aug-00	Sep-00	May-01	Oct-01					
17A	Pretoriuskop	Sep-00	Sep-00	Jul-01						
17B	Komatipoort	Aug-00	Sep-00	Jul-01	Feb-02					
18	Rustenburg	Oct-00	Dec-00	Jun-01	Mar-02	May-02	Jun-02			
19	Piland's berg	Oct-00	Jan-01	Mar-02	Jun-02					
20	Ventersdorp	Oct-00	Feb-01	Sep-01	Mar-02	Jun-02		.		
21	Woodbush	Nov-00	Oct-01							
22	Matalas	No dates								
23	Louis Trichardt	Nov-00	Oct-01	Jun-02						
24	New Belgium (North)	No dates								
25	Blaauwberg	Nov-00	Oct-01	Jun-01	Jul-01					
26&27	Kranzberg	Nov-00	Jun-01	Oct-01	Mar-02					

(continued)

Table 1 (continued)

Sheet no	and name	Comp	Publ	1st Rev	2nd Rev	3rd Rev	4th Rev	5th rev	6th rev	7th rev
28	Zoutpan	Nov-00	Sep-01	Jun-02						
29	Zoutpansberg	not issued								
29A		not issued								
30	Bugelpan	Nov-00	Jun-01	Oct-01	Mar-02	Jun-02				
31	Pafuri	Nov-00	Oct-01	Jun-02						
32	Birthday (Klein-Letaba)	Nov-00	Oct-01	Jun-02						
33	Part of Swaziland (North)	Dec-00	May-01	Jun-01	Apr-02	May-02				
34	Bremersdorp	Dec-00	May-01	Jun-01	Nov-01	Feb-02	May-02			
35	Part of Swaziland, Vryheid, etc.	Feb-01	May-01	Sep-01	Feb-02					
36	Part of Zululand (West)	Feb-01	May-01	Sep-01	Nov-01					
37	Melmoth	Mar-01	Jun-01	Sep-01	Oct-01	Nov-01	Feb-02			
38	Pomeroy	Feb-01	Jun-01	Jul-01	Sep-01	Feb-02				
38A	Ladysmith	Mar-01	Jul-01	Feb-02						
38B	Upper Tugela	No dat	Oct-01							
38D	Pietermaritzburg W	No dates								
38E	Pietermaritzburg E	No dates								
38F	Lower Tugela	No dates								
38G	Natal border of Basutoland	No dates								
38H	Richmond	No dates								
38J	Durban	No dates								
38K	Harding	No dates								
38L	Port Shepstone	No dates								
38M		No dates								
39	Nqutu	Jan-01	May-01	Jul-01	Sep-01	Nov-01	Feb-02			
39A	Dundee	Feb-01	Apr-01	Jul-01	Feb-02					
40	Utrecht-Vryheid	Jan-01	May-01	Sep-01	Feb-02					

(continued)

Table 1 (continued)

Sheet no and name		Comp	Publ	1st Rev	2nd Rev	3rd Rev	4th Rev	5th rev	6th rev	7th rev
41	Piet Retief	Dec-00	May-01	Jun-01	Sep-01	Oct-01	Feb-02			
42	Wakkerstroom	Dec-00	Apr-01	Jun-01	Oct-01	Dec-01	Feb-02	Apr-02		
43	Amersfort	Dec-00	Apr-01	Oct-01	Dec-01	Feb-02				
44	Standerton	No dates	Apr-01	Nov-01	Jan-02					
45	Vereeniging	Dec-00	Feb-01	Aug-01	Oct-01	Jan-02	Jun-02			
46	Potchefstroom	Jan-01	Feb-01	Jun-01	Nov-01	Mar-02	May-02	Jun-02		
47	Klerksdorp	Jan-01	Feb-01	Nov-01	May-02	Jun-02				
48	Geysdorp	Jan-01	Mar-01	Jul-01	Mar-02	May-02	Jun-02			
49	Lichtenburg	Feb-01	Mar-01	Jun-01	Sep-01	Nov-01	May-02			
50	Rooigrond	Feb-01	Mar-01	Jun-01	Nov-01	May-02				
51	Zeerust	Jan-01	Mar-01	Jul-01	Nov-01	Mar-02	May-02	Jun-02		
52	Mafeking	Feb-01	Mar-01	Jul-01	Mar-02					
53	Dwarsberg	Feb-01	Mar-01	Jun-01	Nov-01	Mar-02				
53A	Ramutsa	Feb-01	Mar-01	Mar-01	Jul-01	Nov-01	Mar-02			
54	Mochudi	Feb-01	Mar-01	Jul-01	Mar-02					
55	Wolmaransstad	Jan-01	Feb-01	Jul-01	Nov-01	Mar-02	May-02			
56	Bloemhof	Feb-01	Feb-01	Nov-01	Jul-01	Mar-02	May-02			
56A	Taungs	Feb-01	Mar-01	Jul-01	Nov-01	May-02				
57	Christiana	Feb-01	Mar-01	Jun-01	Nov-01	Mar-02				
57A	Warrenton	Feb-01	Mar-01	Jul-01	Nov-01	May-02				
58	Olifant's River	Not issued								

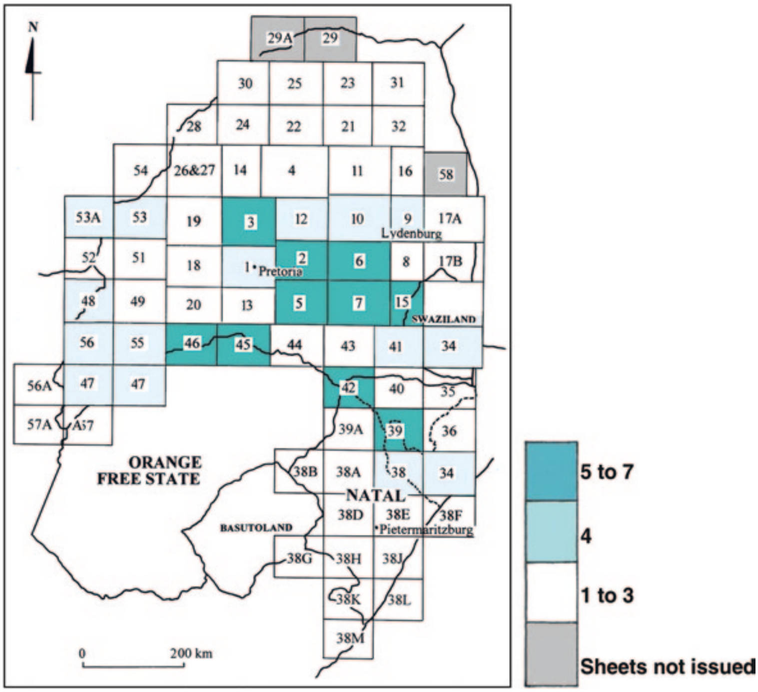

Fig. 16 Number of revisions

6 Conclusion

The development of the Major Jackson Series was an innovative response by the British military authorities to a demand for accurate topographic mapping which they themselves could not fulfil to professionally acceptable standards. Although the maps had many defects, a few positive characteristics resulted in some of them being quite useful for military purposes. They were also used throughout the duration of the war. A redeeming factor contributing to their usefulness was that the work of the No 1. Survey Section was incorporated in the revision of the series. Another was that the Transvaal farm surveys were not only more recent, but from a topographical point of view also better than the older surveys of the Cape Colony and the Orange Free State (Jackson 1906: 276).

Although the publication of the First Transvaal Series was discontinued after the peace treaty was signed on 31 May 1902, the work it entailed was not all in vain. Due to the persuasive power of Her Majesty's Astronomer at the Cape, Sir David Gill, the Geodetic Survey of the Transvaal and Orange River Colonies was executed from 1902 to 1905. Jackson recognised in this scheme the opportunity to issue more accurate maps of the Transvaal and already in January 1901 commenced with the revision of the First Transvaal Series according to new sheet lines which would be connected to the Geodetic Survey (Jackson and Casgrain 1903: 12). This new series, called the “Second Transvaal” or “Degree Sheet” series, was completed by 1909 and was the only maps available of the Transvaal until the 1940s.

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Elri Liebenberg studied at the University of the Orange Free State (SA), the University College of Swansea (UK), and the University of South Africa (Unisa). In 1967 she was appointed to the staff of Unisa; in 1992 she was promoted to full professor, and in 1994 was appointed Head of the Department of Geography. She has been a member of the South African National Committee for the International Cartographic Association (ICA) since 1987; was a Vice-President of the ICA from 1999 to 2003, and since 2007, the Chairperson of the ICA Commission on the History of Cartography. She acts as Regional Editor of the *British Cartographic Journal* for Africa, is a contributor to Volume 6 of the History of Cartography Project of the Chicago University Press, and serves on the Advisory Board for Volume 5. Since 2003 she has been active as a Research Fellow in the Department of Heritage Studies at the University of Pretoria, and in the Department of Geography at Unisa. In 2011 she was appointed Professor Extraordinarius by Unisa.

Part III
The Americas

The Cartographic Discovery of the Great Lakes Snowbelts

Mark Monmonier

Abstract As an elaboration of efforts to map winter precipitation, snow cartography in the United States reflects the need for multiple years of standardized measurements, the uneven development of the measurement network, and perhaps the delayed recognition of "unmelted" snow as a hindrance to mobility. The first systematic maps of snow climatology did not appear until 1894, in the Atlas supplement to Mark Harrington's *Rainfall and Snow of the United States*. A single Atlas sheet titled "Snowfall, in inches" was based on fewer than 100 stations. None of its eight small maps, each covering a single month from October through May, clearly delineates the Great Lakes snowbelts. Between 1912 and 1914 Harvard graduate student Charles Franklin Brooks, who wrote a doctoral dissertation on the geography of snowfall in the eastern United States, produced a series of comparatively detailed snowfall maps. Subsequent refinements reflect an enhanced data-collection network, a longer period of record, and a wider range of snow-related map themes. Extension of coverage to the western third of the country, where annual snowfall rates vary widely over short distances, dampened detail for the East when isoline intervals were held constant across the map—a cartographic "hushing" if not a full "silence." A conceptual bifurcation is apparent in the latter decades of the twentieth century, with the emergence of probabilistic maps based on a trove of temporal data as well as increased use of single-storm maps based on numerical simulation, dynamic radar, and satellite imagery to better understand and predict lake-effect snowstorms.

1 Context and Overview

This chapter is based on a book (Monmonier 2012a) published in fall 2012 on lake-effect snow, specifically the chapter titled "Discovery." Several of the quotations and maps in that chapter are also featured in a short article (Monmonier 2012b)

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in the July/August 2012 issue of *Weatherwise*, a popular magazine for weather enthusiasts and amateur meteorologists. The book offers a longer, more detailed examination of the “discovery” of lake-effect snow, whereas the article includes obligatory anecdotes about extreme weather. By contrast, the present chapter frames the emergence of snowfall maps as a consequence of not only the development of appropriate measuring techniques and observation networks but also the evolving scientific interest in snow.

Both the book and this article are rooted in the history of cartography insofar as I set out several years ago to write a short paper on early maps describing lake-effect snow, a weather phenomenon associated most strongly with the lee shores of the Great Lakes of North America. When my search for early snowfall maps uncovered a decidedly slow recognition of the lake effect in the scientific literature as well as on maps of weather and climate, I recognized a broader, no less intriguing story that could be addressed to general readers in a book of seven carefully sequenced chapters, each with an expressive one-word title: Recipe, Discovery, Prediction, Impacts, Records, Change, and Place. For example, “Recipe” examines key ingredients of the “lake effect,” which begins with the southward or southeastward movement of arctic air across relatively warm lakes from late fall through early spring; the lakes provide heat and moisture for elongated convective storms that can deposit large amounts of snow as the moist, unstable air moves onto the land, where surface friction and orographic lifting intensify the effect. All seven chapters rely heavily on maps, both historic and contemporary.

“Discovery” in the second chapter’s title reflects the gradual realization by weather scientists that snowfall, also called “unmelted” snow, deserved to be measured, recorded, and mapped. When meteorological cartography emerged in the mid-nineteenth century, snow was captured outside in a cylinder with a known diameter, brought indoors, and reduced to a quantity that could be reported in inches, along with rainfall, as precipitation (Hagarty 1963). This myopic tendency to melt snow at least partly reflects the overriding importance of total precipitation, with spatial and temporal variations more directly useful to discussions of agriculture and flooding. By contrast, snowfall, defined as the depth of snow that accumulates during 12 or 24 h, is notoriously difficult to measure for a variety of reasons, notably drifting and compaction.

Standardized measurements and a reliable network of conscientious observers are essential to the coherent mapping of snowfall, which made little progress until the 1890s. Although maps had begun to document the geography of snowfall, snow was not yet the nuisance it became around the time of World War I, when automobiles and trucks replaced sleighs for winter transportation along city streets in more northerly latitudes (Mergen 1997: 54–67). Moreover, the first insightful explanation for lake-effect snow, advanced in 1921, was more serendipitous than cartographic. Even so, observation networks continued to evolve throughout the twentieth century as snow cartography underwent an expansion from more purely descriptive climatology to operational forecasting and probability-based climatology.

Geographic climatologist Val Eichenlaub endorsed the phenomenon in 1970 with his classic, highly generalized delineation of the Great Lakes snowbelts, in

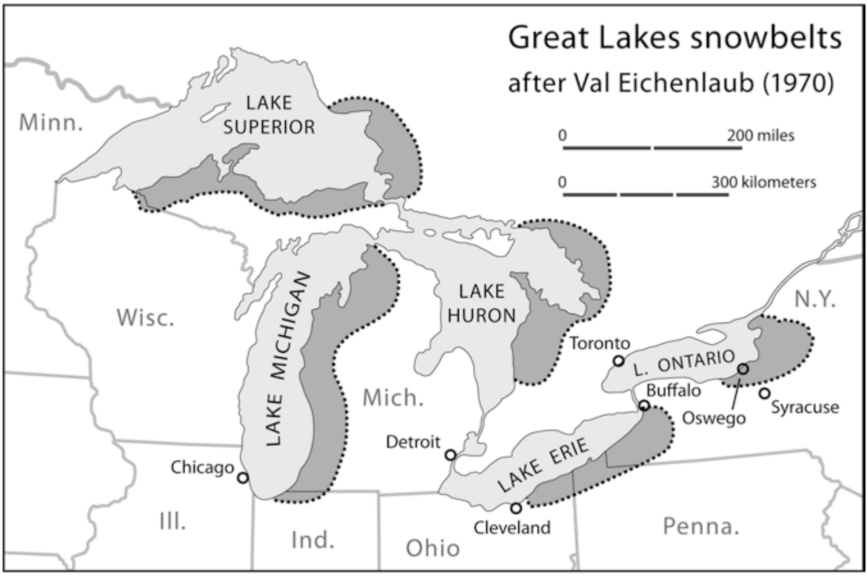

Fig. 1 Snowbelts redrawn from Eichenlaub (1970: 404)

Fig. 1. He drew boundaries to reflect "zones of heavier mean annual accumulations extending from 20 to 40 miles inland [with] sharp gradients toward the interior" and specifically avoided outliers (Eichenlaub 1970: 404). The actual extent, he conceded, could vary markedly from one year to the next.

2 Early Neglect

I started my research by poring through some old texts to see what nineteenth-century geographers knew about snowbelts. What I found was both disappointing and puzzling. For example, in their 1847 *Geography of the State of New York*, Joseph Mather and Linus Brockett touted the importance of Lakes Erie and Ontario as waterways and noted the threat to lake navigation during autumn of what they called "storms of great violence," but ignored lake snow entirely, even when discussing Buffalo and Oswego County (Mather and Brockett 1847: 16). Equally clueless was John Homer French, who reported the lakes' size and depth in his 1860 *Gazetteer of New York State* but sidestepped their impact on climate. Particularly surprising was the skimpy treatment of snow of any type in the 113-page *Climate of the State of New York*, written by the official state meteorologist, Ebenezer Tousey Turner, and published by the State Assembly in 1894. Turner devoted less than two pages to snowfall, for which relevant data were "very meager for the State as a whole" (Turner 1894: 422). Aware of "very heavy local amounts in the southwestern counties, especially in the vicinity of Lake Erie and portions of Lewis, Oneida, and Madison Counties, where the total snowfall is generally the greatest to be found east of the Rocky Mountains," he made no connection with warm lakes and polar air (Turner 1894: 423). Turner was even more frustrating in his article "The Climate of New York," published in 1900 in the *Journal of the American Geographical Society* and reprinted as the chapter on climate in Ralph Tarr's 1902 *Physical Geography of New York State*, aimed at geography teachers. In a section headed "Influence of Great Lakes," he noted that "the northwesterly winds of winter, in passing over the lake, are raised to a temperature considerably higher than obtains on the north shore" but said nothing here about snow, despite observing that "this influence is felt throughout the portions of the State lying to the south and east of the lake" (Turner 1902: 338–39).

Perhaps the first step toward the cartographic recognition of lake-effect snow occurred in 1855, when the U.S. Surgeon-General's Office, which had been collecting weather data at military bases, published its *Meteorological Register*, based on 12 years of data, from 1843 to 1854. The report contained a number of maps, including a map of winter precipitation (Fig. 2). As was customary, snow was melted and lumped together with rain. The network was too sparse to reveal any hint of snowbelts. The title plate attributed the map to Lorin Blodget (1857), who published his own, slightly different version two years later in his textbook *Climatology of the United States*.

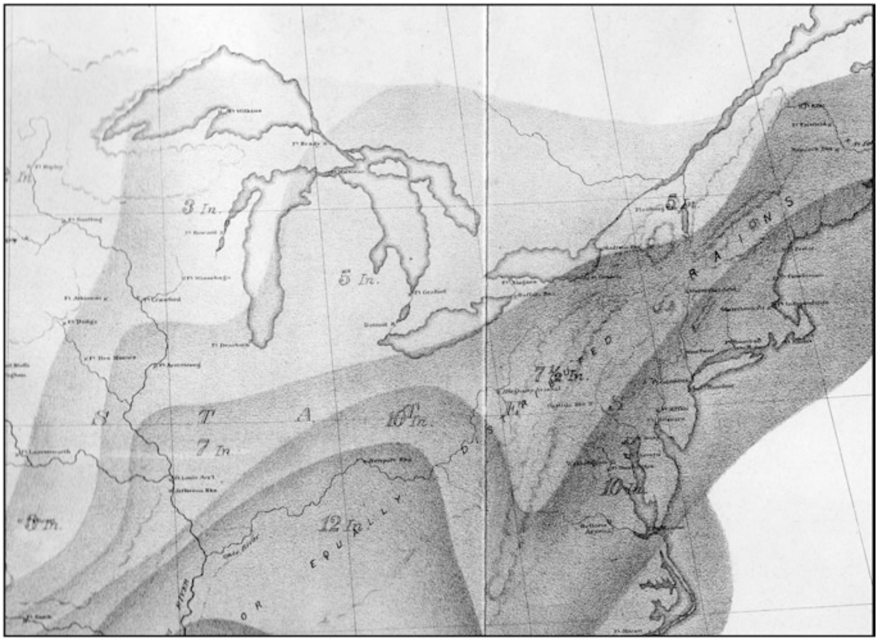

Fig. 2 Great Lakes portion of the map of winter precipitation, in inches, from the 1855 *Meteorological Register* (US Surgeon-General's Office 1855: back)

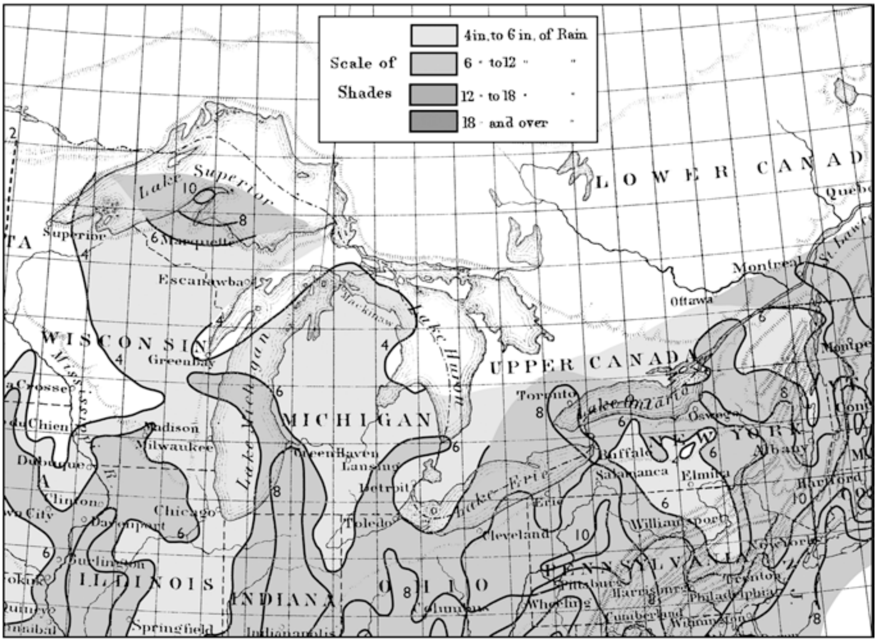

Fig. 3 The Great Lakes portion of Charles Schott's map of winter precipitation, converted from color (blue and black) to grayscale and with map key relocated (Schott 1872: back)

An 1872 report by U.S. Coast and Geodetic Survey scientist Charles Schott in collaboration with Joseph Henry, director of the Smithsonian Institution, also included a separate map of winter precipitation based on 790 stations (Fig. 3). As was customary, Schott combined rain and melted snow. The map shows higher values to the lee of Lakes Superior and Ontario (in particular) and, to a lesser extent, downwind from Lakes Michigan and Erie. This greater clarity probably reflects the Smithsonian's denser observation network. Particularly noteworthy are the isohyets northwest of Marquette, on Michigan's Upper Peninsula. Even so, Schott said nothing about lake-effect snow, and even dismissed the Great Lakes' contribution to regional rainfall. Moreover, he opined, "Beyond furnishing by their evaporation a supply to the general fund of moisture, the Great Lakes do not appear to exercise any direct influence. There is even a remarkably small amount of rain-fall in northern New York, close to Lake Ontario" (Schott 1872: 121).

A map of winter precipitation (Fig. 4) from the *Fifth Annual Report of the New York Meteorological Bureau and Weather Service*, published in 1893, offers little hint of snowbelts, except for Tug Hill, due west of the Adirondacks, where the orographic effect is particularly prominent. As with earlier maps, melted snow is combined with rain. The isohyets reflect data from only 80 observers, in contrast to Schott's map, which drew on 132 stations throughout the state.

The first systematic national maps of snowfall were published in 1894, in the large-format Atlas supplement to the report *Rainfall and Snow of the United States*,

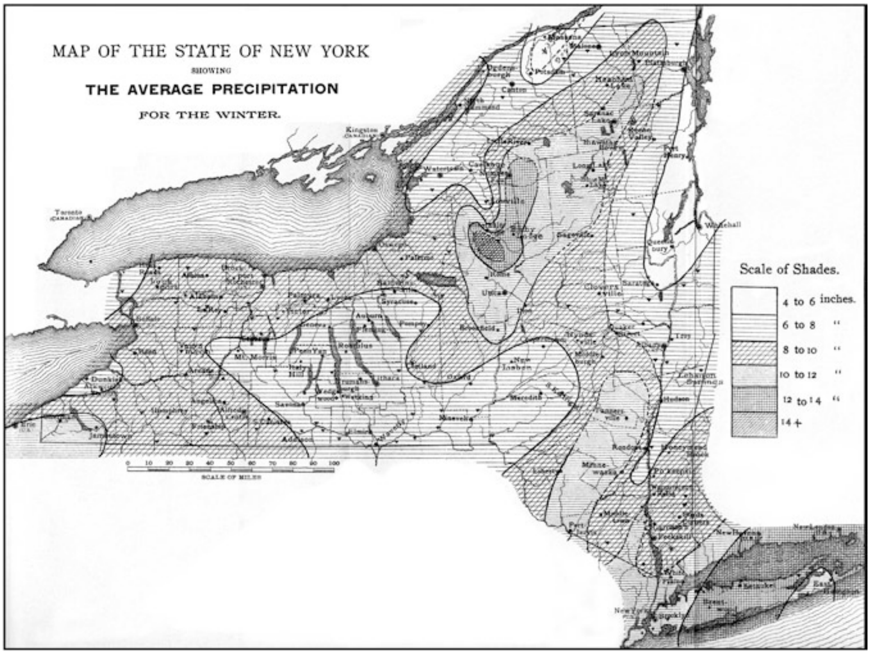

Fig. 4 Map of winter precipitation from the *fifth annual report of the New York Meteorological Bureau and Weather Service* (1893: back), converted from color (blue and black) to grayscale

by Mark W. Harrington, first civilian chief of the U.S. Weather Bureau. A single Atlas sheet titled "Snowfall, in inches" juxtaposes eight small maps, each covering a single month from October through May. The maps reflect a network of fewer than 100 stations. Although the period of record is reported as 1884 through 1891, Harrington's isolines are based on values representing five to twenty years of data.

Although none of Harrington's maps clearly delineates the Great Lakes snowbelts, his October map (Fig. 5) shows more than five inches of snow to the lee of Lake Superior and more than an inch in a broad area east of Lake Michigan. It's a bit early for lake-effect snow from Lakes Erie and Ontario, and the orographic impact on mountain peaks in the West is conspicuously absent because, as he explained, the maps were "only for snow in the vicinity of the stations, the depth remaining on mountain peaks not being considered" (Harrington 1894: 16). His network comprised fewer than 100 stations, many of which were too far south to be of much use.

Although Harrington, somewhat oddly, did not provide a mean annual map of snowfall, textbook author Frank Waldo filled the bill two years later with a whole-year snowfall map (Fig. 6), apparently derived by summing Harrington's maps or their data, which accounts for unrealistically low totals in the Rocky Mountains. Although snowfall is heaviest in the northeastern states along the border with Canada, the snowbelts delineated by Eichenlaub (Fig. 1) are not apparent in the isolines, except perhaps along the south shore of Lake Superior.

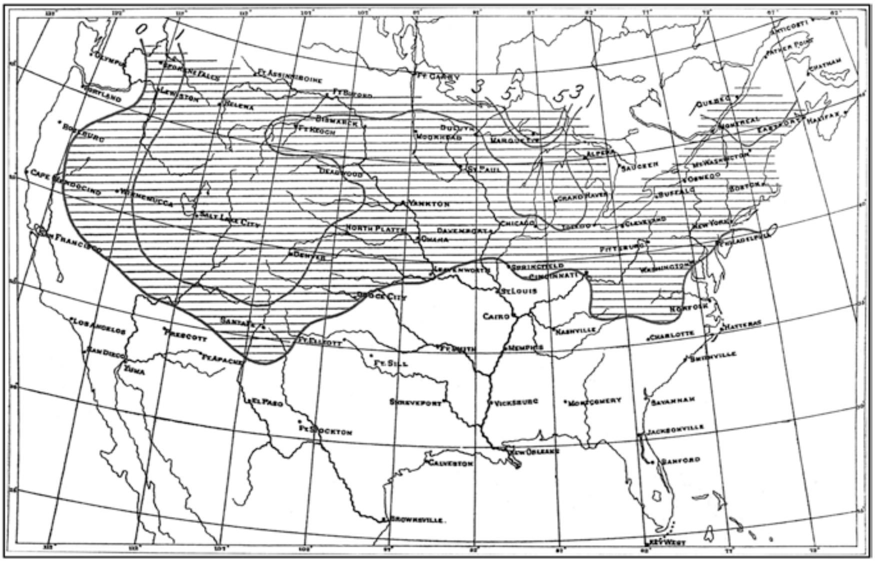

Fig. 5 Average October snowfall, in inches, from Harrington's 1894 atlas, converted from color (orange and blue) to grayscale (Harrington 1894: sheet xviii)

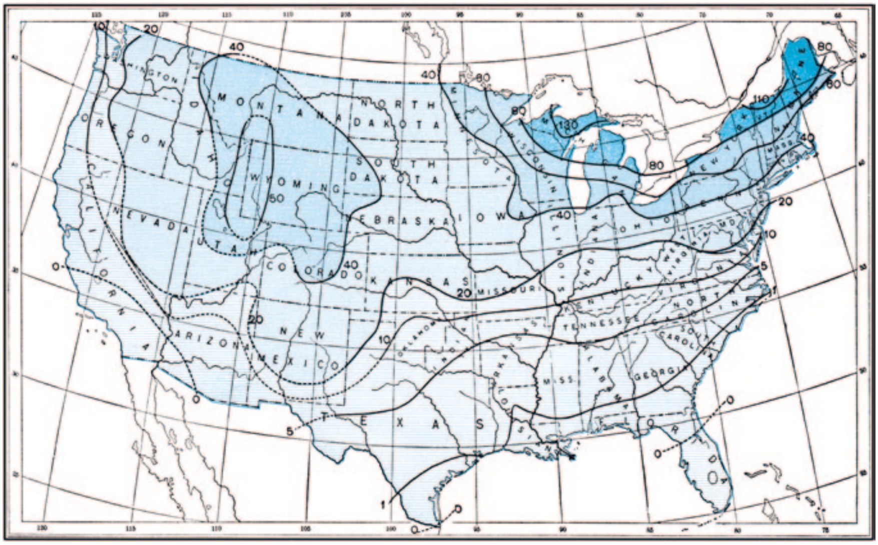

Fig. 6 Waldo's map of annual average snowfall, in inches (Waldo 1896: facing 345)

In 1898 Alfred J. Henry, who headed up the Weather Bureau's Records Division, published a whole-year snowfall map in the *Monthly Weather Review*. Based on 159 stations in the United States and 24 in Canada, his map covers the period 1884

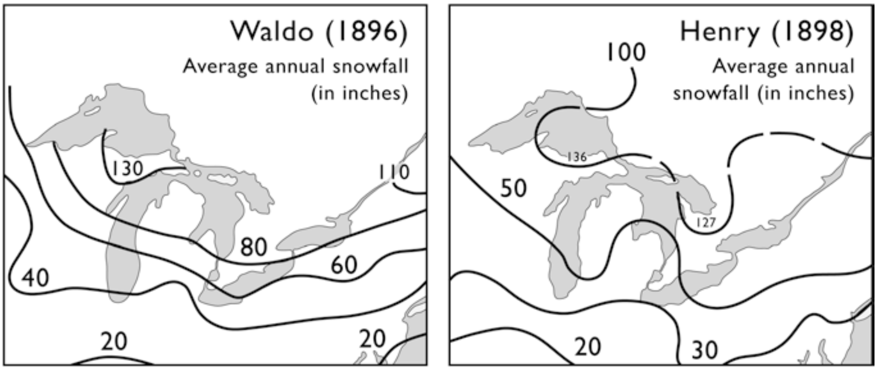

Fig. 7 Comparison of isolines near the Great Lakes on the snowfall maps of Frank Waldo and Alfred J. Henry, redrawn by the author from Waldo (1896: facing 345) and Henry (1898: chart 11)

through 1895, addresses the western mountains more fully than Waldo's map, and shows heavier snowfall on the lee shores of Lakes Superior and Michigan than farther to the south and east. Figure 7, which compares the maps of Waldo (left) and Henry (right), illustrates the greater detail possible with a small interval between isolines. Henry's map, which lacks isolines between 50 and 100 in., ignores lake snow east of Lake Ontario and only faintly hints at a Lake Erie snowbelt between Cleveland and Buffalo. His choice of isolines might explain—but not excuse—his failure to recognize the Lake Erie and Lake Ontario snowbelts. Indeed, this overly broad interval between isolines exemplifies what might be called "cartographic hushing," a form of method-induced cartographic silence that suppresses locally meaningful details in order to avoid clutter elsewhere on the national map. That said, Henry included specific annual averages in two places (in southern Ontario and the Upper Peninsula) that might otherwise have gone unrecognized as local peaks.

The next significant contributor was Harvard graduate student Charles Franklin Brooks, whose short article in the *Quarterly Journal of the Royal Meteorological Society* for 1913 includes an average annual snowfall map based on over 1,000 stations, about 700 of them in the East (Brooks 1914: 17). Figure 8, which juxtaposes the map key with an enlarged excerpt for the Great Lakes, clearly delineates snowbelts downwind from all five Great Lakes. Note the comparatively large amounts of snow due south of Lake Superior and due east of Lake Ontario.

3 A Detailed Delineation and an Emerging Explanation

In 1914 Brooks successfully defended a doctoral dissertation on the geography of snowfall east of the Mississippi, based largely on data from the secondary network of "cooperative" observers, which was markedly denser than the primary

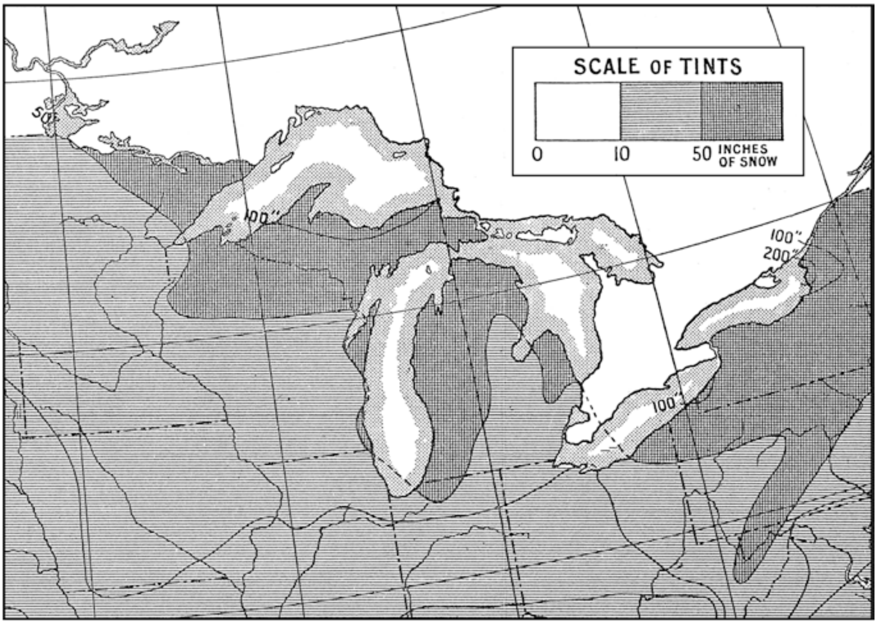

Fig. 8 Great Lakes portion of Brooks' 1913 map of average annual snowfall, in inches, with the map key relocated (Brooks 1913: foldout between 82 and 83)

network of Weather Bureau offices. A separate oversize Atlas section includes the eastern half of the U.S. Geological Survey's 1:7,000,000 Relief Map of the United States—an actual printed copy cut in half—as well as multiple copies of the corresponding portion of the USGS 1:7,000,000 Contour Map, on which he plotted isolines showing average annual snowfall as well as average monthly snowfall for September through May. Although the process of interpolation is not altogether clear, Brooks based his lines of equal snowfall mostly on 325 stations east of the Mississippi with complete data for the period 1895–1913 and an additional 206 stations with partial data for these 18 years. Where these data points were sparse, he used stations with as few as six years of data (Brooks 1914: 18–21).

Figure 9, which focuses on the Great Lakes, is redrawn from his large-format map of annual average snowfall. Its isolines reflect the general trend and position of Eichenlaub's highly generalized snowbelts (Fig. 1). By contrast, the monthly snowfall maps illustrate the progressive advance and retreat of snow, including the effect of the Great Lakes, where "early in winter the snowfall of the immediate shores is generally less than a short distance inland, particularly where the land rises more or less abruptly from the shore" (Brooks 1914: 31).

On monthly maps for December through March Brooks plotted wind roses at 79 stations to examine the relative frequency of snow-bearing winds in the eight major directions. Based on surface winds, rather than winds aloft, and not reflecting the intensity of snowfall, these charts "do not show any striking prevalence of snow

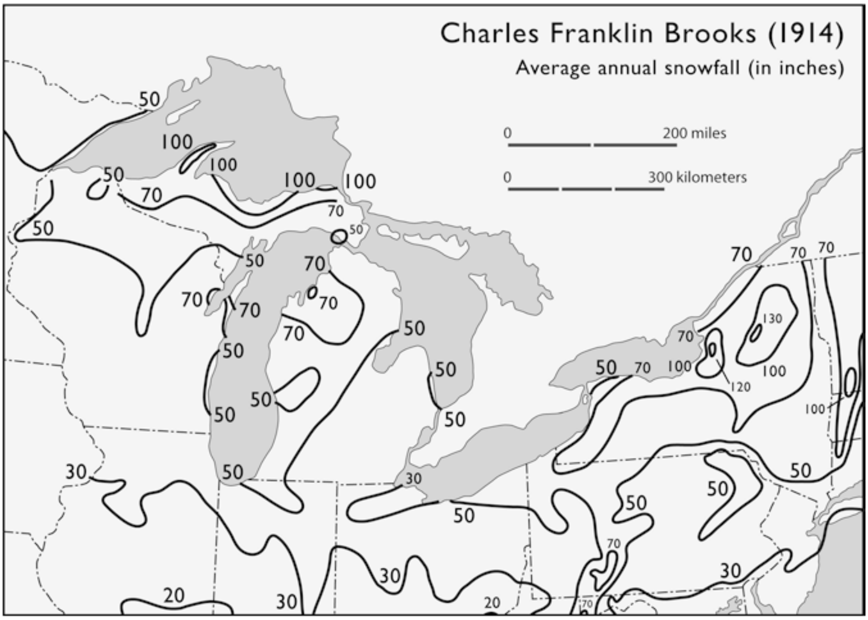

Fig. 9 Charles Franklin Brooks included this more detailed snowfall map in his dissertation; excerpt redrawn from Brooks (1914: chart XV)

with winds from the lakes" (Brooks 1914: 34). In the main part of the dissertation four smaller maps, two apiece on letter-size (8.5 × 11 in.) sheets, describe the patterns of mean annual snowfall, maximum annual snowfall, minimum annual snowfall, and the extreme range of annual snowfall in the vicinity of the Great Lakes. Brooks based them on "about 100 stations" with reliable data for 1895 through 1910. "In general," he observed, "the snowfall is heavier in the north than in the south, and much heavier on the east shores than on the west" (Brooks 1914: 26).

Brooks also mapped the average annual number of days with 0.1 in. or more of snowfall over the same period for the entire eastern United States. His map shows that the Appalachians and the mountains of northern New England as well as the Great Lakes snowbelts experience 50 or more snow days in an average year. In addition he used paired maps of daily snowfall and the 8 a.m. pattern of temperature, pressure, wind direction, and sky conditions to explain the development and course of two significant cyclonic snowstorms, on 10–14 February 1899 and 20–23 February 1912. The latter storm exemplifies what meteorologists now call a lake-enhanced snowstorm. As Brooks noted, "Numerous strips and islands stand out prominently, particularly those on the east shores of the Great Lakes and in the Appalachians" (Brooks 1914: 56).

Snow cartographers who came after Brooks introduced refinements possible with an enhanced data-collection network, a longer record, and a presumably more rigorous supervision of taking and reporting measurements (Monmonier 2012a).

Although their maps of average annual snowfall differ noticeably in the configuration of their isolines, all of them reported regionally heavy concentrations along the lee shores of the Great Lakes, and particularly in the Keweenaw Peninsula (in northern Michigan) and Tug Hill (east of Lake Ontario), where orographic enhancement adds to the lake effect.

4 From Description of Pattern to Explanation of Process

In addition to delineating snowbelts, Brooks offered a plausible interpretation. “In winter,” he posited, “moist cyclonic winds, blowing from a comparatively warm water surface onto cold land, cause increased precipitation chiefly by forced ascent of the wind due to increased friction and to topography [resulting in] heavy snowfall on leeward shores,” which receive “fairly regular west-wind snowfall plus the irregular cyclonic snowfall” of passing storms (Brooks 1914: 30–31).

A fuller appreciation of the role of convection emerged in 1921, when a profile diagram drawn by Wilfred Day (Fig. 10) accompanied a short note in the *Monthly Weather Review* by Charles Mitchell. Based on direct observation rather than a cartographic summary of climatic averages, this diagram provides what might be the most concise, if not the earliest, scientific explanation of lake-effect snow.

Day and Mitchell worked in the Weather Bureau’s Chicago office. Their two-page article “Snow Flurries along the Eastern Shore of Lake Michigan” listed Mitchell as the author and credited Day with the piece’s sole illustration. What Day contributed to the collaboration was several years at the Weather Bureau office in Ludington, Michigan, his first posting, and an aptitude for sketching, honed off-hours at the Chicago Academy of Fine Arts.

Ludington is midway along the lake’s eastern shoreline, and conversations about Day’s experiences might have roused Mitchell’s curiosity about lake snow. “How far back over Lake Michigan [did] these flurries extend,” he wondered, and what caused them? For an answer he wrote officials of the Pere Marquette Railway, which operated car ferries from Ludington across to Milwaukee and Manitowoc, Wisconsin. The three ferry masters who replied recalled seeing steam or fog rising as far back as the lake’s western shore, which typically meant snow east of the lake, particularly in early winter, when the water surface, at around 40 °F in early December, was much warmer than frigid air from the west and north.

Mitchell reasoned that the lake was covered by “a layer of warmer air” that was “necessarily quite shallow along the western shore” but thicker “toward the east,” where—as he put it—“convectional currents and turbulence set in, manifesting themselves in clouds farther out in the lake and snow flurries where convection and turbulence are sufficient to produce it” (Mitchell 1921: 502–3). Although lake snow could be intense, Chicago forecasters used the term snow flurries to distinguish it from conventional snowstorms (also called synoptic snowstorms) associated with centres of low pressure.

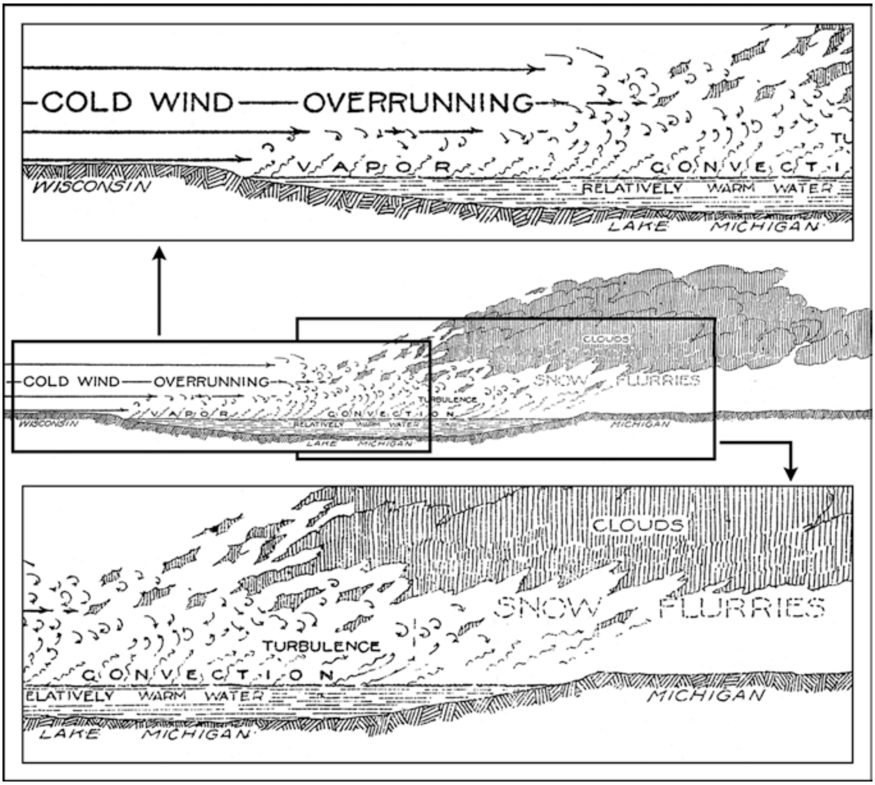

Fig. 10 Wilfred Day's graphic explanation of lake-effect snow (Mitchell 1921: 502). Overlapping detail images enhance a long, shallow drawing (190 mm wide) that doesn't fit legibly on a page of this book

Day summarized the process with an insightfully concise diagram. With appropriate vertical exaggeration, it reads from left to right, like a sentence, to explain an atmospheric process that evolves from west to east. The tale begins with rising water vapour as cold wind overruns the lake's relatively warm water. About halfway out the rising vapour triggers convection, which then carries the condensing moisture to still higher levels, creating turbulence, tall clouds, and "snow flurries" over land. As both a cross-sectional view and a time line, Day's graphic narrative complements today's overhead images, captured by geostationary satellites or constructed with Doppler radar, in which the two-dimensional form of a typical snowband grows steadily wider downwind as its advancing convection cell grows in intensity, height, and breadth (Monmonier 1999: plates 11, 12).

Cartography contributed to meteorologists' understanding of lake-effect snow by suggesting a strategy for forecasting localities where an influx of polar air is likely to produce snowbands. Because high pressure pushes air toward a region of low pressure, a weather map's isobars, which describe pressure trends, can explain—and

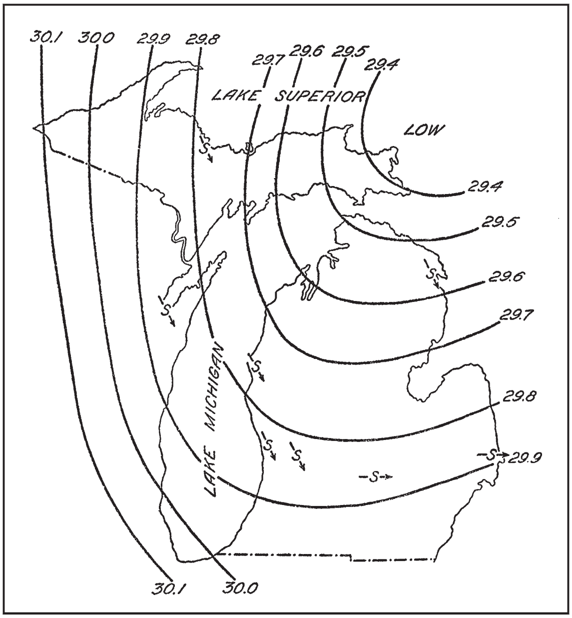

Fig. 11 Typical pressure condition favorable for snow squalls over Michigan, from Dole (1928: 512)

in a sense predict—wind direction. In 1928, in another two-page *Monthly Weather Review* article, Robert M. Dole, an assistant meteorologist at the Lansing, Michigan, office, used a hypothetical weather map to demonstrate the general relationship between pressure, wind, and lake-effect snow. His map of "typical pressure conditions favourable for snow squalls" (Fig. 11) reflects a low-pressure cell centred over Ontario, off the map to the northeast. Tiny arrows portray a counterclockwise flow of air, a response to the Coriolis force, which deflects wind to the right (in the northern hemisphere) as it moves inward toward the centre of low pressure. In late fall or winter, nearly north–south isobars like those shown here will direct cold northwest winds across a substantially warmer lake surface, producing "enormous clouds very similar to thunderstorms in appearance." But instead of heavy rain, downdrafts of cold air reach the surface "in the form of snow squalls" (Dole 1928: 512). Dole didn't mention *fetch*, the contact distance between air currents and the lake surface, but it is clear that these northwest winds are favourably aligned to pick up lots of moisture.

5 Concluding Remarks

A conceptual bifurcation in the cartographic analysis of lake-effect snow occurred in the latter decades of the twentieth century, with the emergence of probabilistic maps based on temporal data and an increased use of single-storm maps as well as dynamic radar and satellite images to better understand and predict lake-effect snowstorms

(Monmonier 2012a). Particularly noteworthy are the diverse cartographic portraits addressing ground snow load, multi-lake snowbands, 36 h predictions, and "lake-induced changes in winter precipitation"—an attempt to differentiate lake-effect snow from that generated by synoptic-scale processes (Scott and Huff 1996).

Discovery of the lake-effect snowbelts and fuller understanding of the dynamics of lake-effect snow relied heavily on the development of an observation network sufficiently dense to explore a physical process operating on a more local scale than the synoptic storms that inspired development of a national weather service in the nineteenth century (Fleming 1990). This exploration was still underway at the end of the twentieth century, when meteorologists had only recently recognized related phenomena such as multi-lake snowbands, bay- and ocean-effect snowstorms, and lake-effect snowbands off smaller water bodies like Lake Champlain and New York's Finger Lakes. Not surprisingly, these studies depend heavily on cartographic imagery captured by satellite and radar or generated by numerical simulation.

It is difficult to claim definitively that snow's emergence in the late nineteenth century as a scourge of urban transportation inspired the systematic recording and mapping of "unmelted" snow, which led in turn to the cartographic discovery of the Great Lakes snowbelts. A plausible argument can be made that appreciation of snowfall data—measurements now performed systematically by thousands of volunteer observers equipped with little more than a ruler and a board 2 feet square (Cifelli et al. 2004)—more likely reflects the bureaucratic momentum of a growing and increasingly assertive national weather forecasting service. Why atmospheric scientists marginalized the simple measurement of snowfall for several decades might be rooted in their preoccupation with more violent and destructive phenomena like hurricanes, tornadoes, northeasters, cold waves, and blizzards. Although lake snow can be notoriously persistent, it is almost always a comparatively gentle phenomenon, whereas a blizzard is essentially a severe windstorm with snow. And blizzards are far more common on the Great Plains than along the Great Lakes.

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Mark Monmonier (Ph.D., The Pennsylvania State University, 1969) is Distinguished Professor of Geography at Syracuse University's Maxwell School of Citizenship and Public Affairs, where he teaches courses on map design, environmental hazards, and the societal implications of cartographic technology. He is the editor of Volume Six of the *History of Cartography*, which focuses on the twentieth century, and the author of sixteen books, including *Air Apparent: How Meteorologists Learned to Map, Predict, and Dramatize Weather* (1999) and *Lake Effect: Tales of Large Lakes, Arctic Winds, and Recurrent Snows* (2012). For diverse contributions to cartography, he was awarded the American Geographical Society's O. M. Miller Medal in 2001, the Pennsylvania State University's Charles L. Hosler Alumni Scholar Medal in 2007, and the German Cartographic Society's Mercator Medal in 2009.

"You may all go to hell, and I will go to Texas"

Land Titles, German Immigration and Mid-Nineteenth Century Cadastral Cartography

Imre Josef Demhardt

Abstract Until the 1700s Texas was a peripheral and sparsely settled province in the Vice-Royalty of New Spain. Land grants by Spanish (until 1821) and Mexican (1821–1835) administrations stimulated an influx of Anglo-American settlers who soon seceded to form the short lived Republic of Texas (1836–1845). During this period the still prevailing system of property survey and mapping was established. In the first decades of U.S. statehood (since 1846), German immigrants were instrumental in improving the hitherto crude cadastral cartography by refining the County Maps, the key cadastral instruments in visualizing the land titles at the Texas General Land Office.

1 Spanish and Mexican Land Grants in the Province of Tejas

Well into the eighteenth century the province of Tejas was a barely known and insignificant tract of land on the northeastern frontier of the Spanish Vice-Royalty of New Spain with only a few hundred widely scattered European settlers. In an

About the chapter title: An American phrase still used for a bold stride to turn one's fortune in a new land, coined by David Crockett (1786–1836), a Kentucky frontiersman and U.S. politician, when in 1834 he lost the re-election and sought a better fortune in Texas. There he joined the fight for independence and became immortalized as one of the defenders killed by Mexican troops taking the besieged Alamo in San Antonio, since then the symbol of Texan virtue, on March 6, 1836; Todish et al. (1998) Alamo Sourcebook, 1836: A Comprehensive Guide to the Battle of the Alamo and the Texas Revolution. Austin. The present article does accentuate some of the author's cadastral observations in a broader journal chapter on Nassovian immigrants to Texas: Hin nach Texas, hin nach Texas, in: *Nassauische Annalen*, Volume 123 (2012), pp. 505–537, which also contains a number of color illustrations.

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effort to fend off French encroachments from the neighbouring Louisiana, where in 1718 Nouvelle Orléans had been founded, and the constant threats by native Indians, the notoriously cash-strapped Spanish colonial administration, unable to maintain costly military outposts, resorted to encourage the immigration of white settlers. These obtained as from 1767 title patents for individual grants of land of usually one *legua* pasture (1,797 ha) and one *labor* agricultural land (72 ha) (Miller 1972; John 1975). According to the Louisiana Purchase of 1803, the United States of America acquired the largely nominal French land claim between the Mississippi and the crest line of the Rocky Mountains. Although the Adams-Onís-Treaty of 1819 settled a demarcation line with New Spain, there was a rising influx of Anglo-American pioneers pushing into the fertile yet largely unsettled farmlands across the new boundary (Brooks 1939).

Since 1810 faced with an independence movement in the heartlands of Mexico, Spanish authorities pragmatically gave into the unstoppable filtering in of Anglo-American settlers and restricted themselves to canalize it by comprehensive land grants, the system of empresarios. These entrepreneurs in exchange organized the settlement, undertook the surveying of individual land parcels, and vouched for the loyalty of 'their' settlers. The trailblazer for the finally more than forty empresarios, who in less than two decades had snatched up, at least on paper, most of the province of Tejas north of the Nueces River, was U.S. citizen Stephen F. Austin, whose land grant of 1821 provided for 300 settlers with each family obtaining 1,280 acres (520 ha) (Barker 1925). In the same year the Mexican independence movement succeeded and established a troubled federal republic. Reluctantly continuing the empresario system, the uneasy relation between the administration and the ever growing number of immigrants resulted in the March 4, 1836 secession of the Anglo settlers which they defended in a bloody war of independence, culminating in the victorious battle of San Jacinto on April 21. In addition to the Spanish and Mexican land grants, the newly founded Republic of Texas awarded each freedom fighter a so-called headright of one *legua* (1,797 ha) (Miller 1961).

2 Republic of Texas 1836–1845 and its General Land Office

On achieving independence, the Republic of Texas was practically broke because of the burden of debts accumulated in the brief but intense war of independence. In the absence of a developed economy with its stream of tax revenues, the lone and only asset with a long term perspective to keep the republic afloat, was the inherited vast tracts of not sold or granted state lands. These areas had an immense economic trickle-down potential, provided that they could be sold, settled, and brought to good use. It is therefore not surprising that the first institution founded by the new republic was the General Land Office (from now on abbreviated GLO) which, on October 1, 1837, opened its doors for business in the then state capital of Houston in the northeastern corner of the state. But already in 1839 it moved along with all government offices to the new purpose-built capital city of Austin, deep in the heart of Texas.

The first task of the GLO, however, was not the registration of new land titles, but the collection of widely dispersed documents on Spanish and Mexican land titles and their verification as the constitution of the Republic of Texas granted recognition to all lawfully acquired land patents. Since especially older Spanish land grants had never, or only improperly, been recorded, this verification process completely occupied the emerging office and only fizzled out in the last quarter of the nineteenth century. In the end, about 4,200 pre-independence land titles totaling 26.28 million acres (106,300 km^2) were accepted (Morgan 1992). Initially staffed only with a handful of clerks, none of them a trained surveyor or draftsman, the GLO in its reports to the Texas parliament regularly requested the hiring of at least one experienced draftsman, but was always stonewalled by the actuaries of the skinflint bureaucracy. The first Commissioner of the GLO, John P. Borden, on October 23, 1839, informed parliament that his office, besides being burdened with the verification of old land patents, had not yet, three and a half years after independence, been able to register any new *headrights for two principal reasons* viz*: the want of necessary connected maps and the great uncertainty in the genuineness of the claim upon which many of the surveys have been made.* (Texas General Land Office 1839).

Given the extensive size of Texas which equals France, Switzerland and the Benelux States, its scattered pockets of white population, and the lack of a capable centralized land administration, the key legal document of right to land was the County Map, a practice imported from the neighbouring United States, the home of almost all the republic's founders. The County Map as a legal instrument, whether accompanied by document files or not, was drawn and updated by County Surveyors, an elective office not requiring any form of surveying expertise or drafting skills. Consequently the quality of the County Maps varied greatly and was, without exception, of a poor professional standard. Not the least because of these deficiencies, the third GLO-Commissioner, Thomas W. Ward, in the early 1840s refused to register poorly mapped land claims, often also missing any written documentation. This caused widespread anger among the settler communities of counties like Milam and Robertson and almost resulted in the abolition of the GLO by the parliament whose representatives, agitated by disgruntled voters, perceived the office as too pedantic (Texas General Land Office 1986).

Although Commissioner Ward in a report to parliament as late as November 15, 1843 complained that *the Surveyor of a county, although qualified to perform his duties as a surveyor may not be competent to compile such a map as is required by this office: for, the making of maps is the duty of a draftsman and not of a surveyor* (Texas General Land Office 1843), there was a pragmatic band-aid solution in place to live with that unfortunate situation: The GLO contracted on a per job basis the best available freelance draftsmen to revise at least on a makeshift level, and prepare for print, the received County Maps. Thus the mapping of land titles roughly kept track with the rapid settling of Texan landscapes.

One of the requirements for title to land, both under the land grant and the headright system (the latter gradually extended to all post-independence individual settlers), besides duration of settlement on the claim, its active usage, and improvements foremost by building a homestead, was a survey of the farm. In the absence of any triangulation in Texas, the land titles were surveyed according to the practice of colonial English 'metes and bounds' which comprised rough compass bearings, both in running prose and with a basic sketch around the parcel boundaries in sequence, preferring physical features in the terrain or placed monuments such as bottles or stone cairns in the absence of natural marks. Typically, a surveyor was due one dollar per mile surveyed. The surveyor often was not paid in cash, but in land, which added to the already frenzied land speculation in another form. Because of the archaic surveying system, surveyors often tried to stay clear with their insular surveys from neighbouring titles, thus leaving both by need and purpose tracts of land vacant which enterprising surveyors or GLO confidants spotted in the filings and eventually, cheaply because unknown to local land owners and therefore unrivalled, bought as land free for grabs (Watkins 1964).

By 1845, which marked the end of the Republic of Texas, the sum of all effective land titles had reached a total of 41.37 million acres (167,400 km^2 or about a quarter of the current size Texas), of which only 4,49 million acres (18,200 km^2) had materialized from the highly speculative land grants to empresarios. Since most land grants forfeited because the empresarios could not muster sufficient settlers in the required grant period, the overwhelming majority with 36.88 million acres (149,200 km^2) stemmed from the varied and individually assigned system of headrights (Lang 1996).

3 German Immigration to Texas

Perhaps surprisingly, considering the popular image created largely by Hollywood movies, the single largest nationality among the white settlers in Texas by the mid of the nineteenth century were Germans. Arguably the first German to come with his family as settler to Stephen F. Austin's land grant in April 1831, was Johann Friedrich Ernst, a gardener and postmaster from the Grand Duchy of Oldenburg. As often with immigrants who found favourable livelihoods, he wrote glowing letters back home about the potential of the Mexican province of Tejas, triggering a rising tide of emigration and developing the once lone Ernst homestead into the province's first German settlement with the ominous name "Industry". The struggle for independence in 1836 was keenly followed in German newspapers and its result, making available huge tracts of fertile land for settlers, catapulted the Republic of Texas for a while into the top range of destinations of the huge emigration flow from the German States (Jordan 1966).

Given the above, it was not really a surprise that a group of German noblemen, who in 1842 formed a society to guide emigrants, protect these mostly peasant and craftsman folks susceptible to falling prey to villain agents, and save them from exploitation in the settlement areas, turned their attention to Texas as a destination. The 'Society of German Princes and Noblemen for the Protection of German Immigrants to Texas', or shortly known in Texas as 'Adelsverein' (Society of

Noblemen), sent two young earls to do reconnaissance in Texas and to negotiate favourable terms for an intended grand scale immigration project (Gesammelte Aktenstücke 1845). Because the Texan government declined to issue the society a land grant, the Adelsverein, under pressure to obtain land for the already boarded first shipments of emigrants, therefore bought on June 24, 1844, from the newly appointed Texas envoy to the German states, Henry Francis Fisher, a land grant that he and a group of speculators had negotiated from the Republic of Texas two years earlier (see Fig. 1). However, as with most of the empresario schemes, Fisher’s group was unable to attract anywhere near the stipulated number of settlers to fulfil the terms of the grant and permanently secure the allotment of land (Loving 1934).

Of course the very problem with the so-called Fisher-Miller-Grant of about three million acres remained after its sale to the Adelsverein: The land grant was situated about 150 miles to the west of then white frontier and deep in the tribal lands of hostile Indians. Adding to the plight of the society’s settlers, who in large numbers kept arriving at the small coastal village of Indianola on Matagorda Bay as from Fall 1844, was the outbreak of the war between the United States and

Fig. 1 Detail of *Karte des Staates Texas*, Adelsverein 1851, showing topographical patterns of central Texas and administrative boundaries of counties with the German settler’s route (green) towards the Fisher-Miller-Grant (top left). Source: University of Texas at Arlington, Special Collections, Accession No. 310104 (Courtesy of University of Texas at Arlington)

Mexico, effected by Texas joining the Union as 28th state. Because of the requisitioning of the contracted freight wagons, most settlers got stuck for months on the beaches and hundreds died of fever. To eventually get them out of this trap, the first General Commissioner of the Adelsverein, Prince Friedrich von Solms-Braunfels, bought halfway towards the Fisher-Miller-Grant two *leguas* of an old Spanish land grant at the fertile eastern escarpment of the central Texan Hill Country. Here on March 21, 1845, he founded a soon blooming town which he named New Braunfels after his ancestral castle in Germany. Since the new settlement soon ran out of land to accommodate the steadily incoming new emigrant shipments, the second General Commissioner, Johann von Meusebach, bought another stepping stone towards the grant territory and on May 8, 1846, founded Fredericksburg which, too, soon became a thriving town (Biesele 1930).

According to the census of 1860 only about one thousand Whites settled in the Fisher-Miller-Grant, just a sixth of the stipulated quorum by the grant terms for 1846, and only about one hundred Germans were among them. But these figures need to be put into perspective: The Adelsverein in 1844–1847, before defaulting on a mixture of incompetent management and skyrocketing costs, managed to bring a total of 7,400 Germans to emigrate to its more accidently than intended settlement schemes in Texas, while the tide of overall German emigration rose from 32,000 in 1840 to 145,000 in 1852 (Struck 1971). Although at first sight a rather insignificant number, it is to note that these German settlers and their offspring in the census of 1850 constituted nothing less than about 15 % of the overall non-slave and non-Indian population of in total only 49.200 Texans (Jordan 1966). However, by that year the German public already had written off the Adelsverein and its plagued activities in Texas as a grand scale failure.

4 German Draftsmen at the Texas General Land Office

While historians on the other side of the Atlantic still consider the Adelsverein as one of the great failures in canalizing German emigration to America, the picture is completely different on the Texan side of the Atlantic, especially in the cadastral field. Here the Adelsverein settlers were the single most decisive input towards the professionalisation of Texas in mid nineteenth century. Among the more than seven thousand German settlers were not only peasants, but also a large number of craftsmen, people with a military background, and academics, many of whom had gone through an apprenticeship and years of trade practice in fields related to surveying and map making. Not surprisingly, the larger part of this wave of professionals did not stay on lonesome farmsteads for long, but rather looked for self-employed niches as surveyors in the countryside and as professionals in the mushrooming towns. After joining the United States in 1846 the civil service, with the GLO at the front, was finally throwing off the yoke of republic time austerity and was eager to employ the new expertise knocking on its doors. In this win–win situation the GLO personnel not only grew, but for at least the next three decades was dominated by German-born draftsmen along with two GLO-Commissioners in the 1870s (Texas General Land Office 1986; Morgan 1992).

Without doubt the most important German born draftsman at the GLO was Karl Wilhelm Pressler (1823–1907). Born in Thuringia, he passed the examination at the surveying school in Weißensee in 1844 and, after a frustrating stint in the Prussian civil service, came to Texas on board of an Adelsverein ship in February 1846. Because of his education, the land speculator Jacob de Cordova immediately enlisted him as a surveyor and sent him to his far flung acquisitions. In 1849 Pressler copy-edited the first edition (2nd edition 1856) of the best medium scale (1:1.18 million) orientation map of Texas around the mid of the century: *J. De Cordova's Map Of The State Of Texas Compiled from the records of the General Land Office of the State by Robert Creuzbaur, Revised and Corrected by Charles W. Pressler* (published by J.H. Colton & Co., New York). Having made enough money as surveyor to marry and buy a farm, it was only a couple of months later that, in December 1850, Pressler joined the GLO as its first permanently employed draftsman. Serving as military surveyor in the Civil War (1861–1865), he in 1865 returned to the GLO as chief draughtsman and served until he retired in 1899 at the age of 76. His greatest achievement for the GLO, besides drafting more than thirty County Maps, was a manuscript map of Texas jointly drawn in 1879 with A.B. Langermann, depicting land titles, infrastructures, and political entities. With a size of 250 × 250 centimetres, this map remains by far the biggest ever hand-drawn map of the Lone Star State (Pressler 1996).

One of the most extraordinary curriculum vitae of the Adelsverein Germans at the GLO was that of Carl Wilhelm von Rosenberg (1821–1901). This nobleman, a trained surveying army officer and civil architect from eastern Prussia, persuaded his parents and five siblings to immigrate to Texas, where his uncle Ernst Christoph had already made landfall in 1821 as one of the first Germans on record, before disappearing in 1823 in the turbulences after Mexico's independence. The big and affluent Rosenberg family bought a farm to which Carl Wilhelm tended for a couple of years. His skilful plans for the new courthouse of Fayette County caught the eyes of the GLO which hired him in 1856 as a draftsman with a legacy of 11 County Maps. After serving since 1863 as captain with the Confederates in the Civil War, he returned to the GLO only to leave again in 1867, disgruntled about Reconstruction Era favouritism of Union sympathizers which, ironically, otherwise rather helped staunch Union, like most German immigrants, not only in that office. As a lasting legacy Rosenberg, like Pressler, managed to get his son employed as a draftsman who eventually succeeded the elder Pressler as chief draftsman in 1899. Carl Wilhelm himself entered into a land company partnership which went bankrupt in 1876 (Rosenberg Tomlinson 1949).

Other important German draftsmen at the GLO included the mining engineer Georg August Thielepape (1811–1889) who produced more than twenty County Maps (Austin History Center, undated), and intellectuals such as Christoph Conrad Stremme (1807–77). The latter was a trained architect who had worked for the King of Hannover, had completed a doctoral thesis in 1841 on architecture and is relation to culture, and thereafter had a stint at a Russian university. In America

Stremme first ventured into cartography while with the U.S.-Mexican boundary survey in 1853, after which he worked as one of the first professional architects in Texas. In 1856 this landed him the commission to design the new GLO building which today still sits in undeniable German neo-romanesque style on the grounds of the Texan State Congress. After having slipped into a subsequent employment as draftsman until 1874, Stremme drew not only seven County Maps but was instrumental in experimenting with photography and introducing the GLO's advanced photo reproduction lab in the early 1860 s (Texas General Land Office 1989).

In a final comparison of the cadastral maps from the republic era (1836 to end of 1840s) and the early statehood era (1850s and 1860s), the manuscript sheets in the vaults of the Texas General Land Office show a marked difference. The earlier cartographic depictions of titles to land are, at best, raw attempts to distinguish spatial relationships which were almost never drawn to scale and rarely number-referenced to corresponding records in the archives of the office. With the matching extension of GLO professional cartographic staff after the annexation of Texas in 1846 and winning the U.S.-Mexican War of 1846–1848, and the availability of many German trained professional surveyors and draftsmen who dominated well beyond the 1870s, an immediate leap forward is detectable. This includes categories like devotion to detail, quality of execution, and also the output quantity of meticulously drawn, number-referenced, and need-based revisions of cadastral County Maps, all rounded off by a couple of topo-administrative mid-scale orientation maps of the state. As an artistic complement, the German predilection for romanticism is manifested on many County Maps of the 1850s and 1860s in the form of elaborate title cartouches. These playful ornaments, however, rapidly fade away as from the 1870s when preferences changed and a new generation of draftsmen advanced the cadastral mapping of Texas towards standardization and early mechanical (re-)production.

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Author Biography

Imre Josef Demhardt was appointed in 2008 to the Virginia and Jenkins Garret Chair in the History of Cartography and Greater Southwestern Studies at the University of Texas at Arlington. Born and raised in Germany a Christmas present, the 1896 edition of *Andree's Handatlas*, sparked his lasting interest in the history of cartography. He studied Medieval & Modern History (M.A. 1987) and Geography (M.A. 1991, Ph.D. 1995) at the Johann Wolfgang von Goethe University in Frankfurt am Main. Research on exploration, colonialism, and cartographic history directed him to many corners of the globe, but most notably to roam for more than three years sub-Saharan Africa. He has co-curated exhibitions, co-edited five books and is the author of five monographs and numerous scholarly papers on tourism, post-Enlightenment exploration and the cartography of Europe, Africa, and the Americas.

The General Map of Brazil

Paulo Márcio Leal de Menezes

Abstract This paper aims to present the cartographic activities developed at the end of the nineteenth century and beginning of the twentieth century. In addition to the historical chronology, it will present the technical operations and actions during the first and second decades of the twentieth century. In 1889, the need for detailed mapping of Brazil at appropriate scales was confirmed by the Army Staff. In 1896, the study for the General Map of the Republic project demonstrated the specifications and considerations of the cartographic, topographic and geodetic operations to be developed, its work being initiated in 1904. In 1910, contact with Professor Carl Pulfrich, the development of accurate cartographic procedures and others procedures created a new perspective on the mapping projects. After World War I, in 1920, the Austrian Military Cartographic Mission reached Brazil, with the aims of studying the cartographic projection system suitable for mapping the national territory, the surveying for the Federal District Topographic Map and the Topographic Map of Brazil, at 1:1,000,000 scale, celebrating the 100th Anniversary of the Independence of Brazil. From 1922, there were successive internal convulsions in the country. Problems of continuity in mapping grew larger until 1930. In 1932, the Military Geographical Service was renamed the Army Geographical Service and the General Map Commission was abolished. This date marked the beginning for mapmaking and the accurate knowledge of the vast territory of Brazil, with the systematization of mapmaking at several scales, as well as the complete creation of an accurate geodetic network.

1 Introduction

Within the Brazilian concept of cartography a chart is a map involving multiple sheets. Sometimes, when the word 'chart' is changed to the word 'map', this concept is not always emphasized and may cause some misunderstanding of the resulting explanations.

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Following the work of the general commission of the map of the empire of Brazil (GCCE), which ended in 1878, the cartographic work developed in the Empire were largely restricted to the drawing of maps of the provinces and some travel maps. However, maps to support still unresolved border problems were created in support of the work of the Ministry of Foreign Affairs (Coelho 1950).

The proclamation of the Republic of Brazil on November 15, 1889 found the Brazilian territory poorly mapped and inadequate for the vast majority of its needs. Known issues, identified, but not solved, included a lack of a precise geodetic network, the adoption of methodologies that were inappropriate to the extent of the territory and financial difficulties which barred the development of mapping.

Immediately after the proclamation, the need for adequately detailed and scaled mapping was confirmed by the newly created Army, as the material inherited from the Empire could not support any strategic project, either civil or military. Therefore, in 1890, the Military Geographic Service was created, attached to the Astronomical Observatory in Rio de Janeiro. However, the Army was only tasked in 1896 with a project to develop the General Map of the Republic. This study was developed by the Third Section of the Army, and finished on 9 April 1900. It approached the specifications and consideration of geodetic, topographic and cartographic operations to be developed. Each operation presented is rigorously described in detail, aiming for the establishment of a geodetic network and its densification, and technical details for the implementation of the 1:100,000 scale mapping, such as sheet structure, projection, composition of survey classes etc. Based on this study, the Project of the Survey Service of the General Map Survey was completed in April 1901.

Only two years later, in 1903, the Commission for the General Map of Brazil was created, located in Porto Alegre, and its work started in 1904 with the creation of a geodetic network in the State of Rio Grande do Sul. This network was joined to those developed in São Paulo and Rio de Janeiro, creating conditions for the production of some of the first cadastral mapping.

2 The Brazilian Map Project

The document entitled *A Carta do Brazil—Projeto Elaborado no Estado Maior do Exército*, dated 9 April 1900, but printed in 1901, consists of a technical opinion of the Army concerning the study, developed by the Third Section of the Army, on the Organization of the General Map of the Republic. It was divided into three parts with, at the end, four more technical opinions, the first given by Luis Cruls, the second by Orville Derby, the third by a committee of the Geographical History Institute of Brazil and the fourth by a committee of the Polytechnic Institute of Brazil, all praising its structure and scientific vision.

As a general consideration, it states that whatever the intended purpose of a General Map of a country may be, its organization would need to have three distinct types of operations that could be performed simultaneously:

- Geodetic and astronomical operations;
- Topographical operations and
- Cartographic operations.

2.1 Geodetic and Astronomical Operations

The geodetic operations were intended to fix for the drafts or constituting sheets of the general map, the position of known landmarks, around which the surveys carried out would be tied.

It explained that the points should be determined on the ground through creation of approximately equilateral triangles, which would be called the following:

1st Order—when the side length was over 20 km;
2nd Order—when the side length was over 10 km;
3rd Order—when the side length was over 0.5 km.

The set of triangles would form a network and should cover the entire surface of the country, *in the opinion of the most competent geographers* (EME 1901).

Each first-order network started with a precisely measured line, called a base-lines, the ends of which constitute the vertices of the first triangle. The triangulation extended along a great circle, ending in a second base-line, called a check base-line. The second-order network was based on the first-order network, breaking down the first-order triangles into a series of smaller triangles, which in turn were broken down into the third-order network, creating a dense network covering the area to be mapped.

The study presented the case for a triangulation network based on the ideas of Laplace, from March 21, 1817, which referred to the geometric description of a country or a kingdom. Laplace's explanation was, in turn, based on Picard's formulation, developed in 1665. Soon after, however, claims started to be made that, in practice, a triangulation network could not be applied to Brazil due to economic circumstances, and difficulties imposed by the existence of vast regions that would prevent its implementation. One example given referred to the Amazon area, then almost unknown, of 1,730,630 km^2, approximately $3^1/_2$ times larger than France. Likewise, it attempts to justify the impossibility of creating a complete triangulation scheme by reference to the existence of areas of the *Pantanal* (Brazilian Centre West Swamps), of almost equal size. It was claimed that the use of triangulation is not justified for these areas, but rather a network of individual points based on astronomical observations, from which distances and azimuths can be calculated with great precision.

It makes the case that running the triangulation for all work along the coast would require a major effort, starting in Rio Grande do Sul and Rio de Janeiro, with a longitudinal range of 6°, tying into the triangulation schemes that had already been implemented in Minas Gerais and Sao Paulo. Interestingly, a discussion is presented on the triangulation network developed in France, showing that the area covered by the French network, 528,571 km^2, covered an area seven times smaller than that planned for the development of the Brazilian triangulation. In a further comparison with France, it shows the necessity of establishing at least three bands of triangulation along parallels and meridians, completing the comparison, by saying that if the French had taken 27 years to complete their triangulation, from 1818 to 1845, Brazil would take 189 years to deploy its own, with the same support structure used.

The economic evaluation of the expenditure required to carry out the work is precise and detailed, strategically justifying the need for expenditures on the survey. Around the same time Ministry of War began to make demands for the creation of a geographical section, aiming at the incorporation of a future astronomical observatory for the Ministry of War, in view of its task of carrying out precise astronomy. A second demand was for the incorporation of the work in the Army Corps of Engineers.

2.2 Topographical Operations

A description of the topographical operations begins with the assertion of their variability depending on the methods used in the fundamental determination of the locations of points, soil structure, vegetation cover in the area and other highly variable factors.

The method described was based on ‘three way stations’, capable of being used by any instrument, which provided the means for correcting deviations or errors in the different surveys, “even though they were implemented expeditiously”.

Each instrument that can be used is then discussed, and associating the number of operators employed, as well as the speed of observations and the experience of each observer. This leads on to the economic study of the topographic operations.

The discussion which follows relates to how the scale for the general Map of Brazil was determined. It was clear that this determination should follow the rules employed in organising surveys by the mapping organizations of the more advanced nations of the world.

The Map, besides meeting military needs should also be suitable for a range of other uses, such as road building, opening of channels, land demarcation, among others, avoiding the need for preliminary field explorations and helping in the recognition of areas still unexplored. The conclusion was that the Topographic Map was the universally recognized solution.

Regarding the study to determine the best scale to be used, it cites Moessard, stating that it must be sufficiently small that the map could fit on a sheet of

Table 1 Number of sheets of some states of Brazil

States	Area (km^2)	Number of sheets	Actual sheets
Rio Grande do Sul	236,553	130	134
Santa Catarina	74,731	38	42
Paraná	221,319	91	93
Rio de Janeiro	42,000	29	31
Mato Grosso	1,379,651	548	553

ordinary size, be easily carried and should be able to represent a reasonable area of land. Defining the size of the sheet in this way, while requiring a scale sufficiently large to avoid any sacrifice in the representation of terrain details, shows the importance of the map from a military point of view.

For this study, an error of 0.25 mm was considered acceptable, together with the need to be able to show all features greater than 25 m on the ground. From this the ideal scale was established as 1:100,000.

Relating the comments on the defined scale, they show that, at the time, the known area of Brazil was 8,336,393 km^2 (currently 8,514,877 km^2). It is then stated that the representation of the country, if it were a perfect square, at the indicated scale would require a square of 30 × 30 m, but as the shape of the country, extends for about 4,300 km from east to west and 4,500 km from north to south, the representation would require a sheet of 41 × 41 m. Taking into account the division into sheets for convenience of handling, it was established that a sheet size of 0.65 × 0.60 m was optimal, covering an area on the ground of $30' \times 30'$. There would therefore be about 3,000 sheets for full coverage of Brazil. In fact, for this scale, 3,052 sheets of $30' \times 30'$ are needed for Brazil. Table 1 shows how some of the states of the Union were divided.

For carrying out surveys at larger scales, for example at 1:50,000 and 1:25,000, it presented an outline of the division of each 1:100,000 sheet, adopting the layout used by Italy, as shown in the Fig. 1.

It then stated that for a draft (a sheet) at the scale of 1:25,000, covering an area of $7'30'' \times 7'30''$, or 14,000 × 14,000 m, if entrusted to an officer to organize one sheet 1:100,000 per year, it would require a team of 16 officers, then with four groups of 16 officers, the Maps of the States shown in the Table 2 would be completed at the following times (Table 2).

2.3 Cartographic Operations

Regarding cartographic operations, the study defines both the choice of projection and the construction of the Map. It justified the choice of projection based on the size of the country, the general configuration of its outline and its position in relationship to the Equator. It pointed out that, due to the exceptional conditions of the Brazilian territory, the problem was not easy to solve, as it might have appeared (General Map 1900).

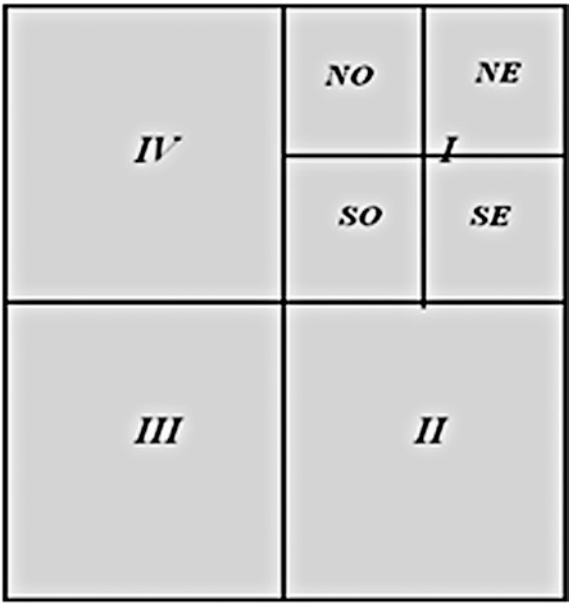


Fig. 1 Scheme of division of the 1:100,000 sheets

Table 2 Time of completion of the 1:100,000 sheets of some states

States	Area (km^2)	Number of years	Notes
Rio Grande do Sul	236,553	22	
Santa Catarina	74,731	7	
Paraná	221,319	20	
Rio de Janeiro	42,000	4	
Mato Grosso	1,379,651	115	

Due to the country extending approximately 40° in latitude and longitude, and its position relative to the Equator, the there would be significant distortions, whatever the projections used. It therefore established a division between topographic maps and geographical maps. It further stated that the ideal type would be one in which the geographical map was an exact reduction of the topographic map. Due to the impossibility of acting in this way, it then chose to use two different projections, each serving its own purpose.

Military operations, roads construction and others similar works would be planned on topographic map sheets, while large group operations (tactical and strategic) would be executed on the geographical map, together with their positioning in relation to major landmarks, which represents a secondary interest in relation to the topographic map.

The following comments in the report are rather interesting, regarding the choice of projection for the topographic map: whatever the projection, any user would always be restricted to using one or a small number of sheets, never the total set of sheets. The best projection would be one that, in addition to providing a precise representation, would allow quick and easy construction of the sheets.

2.4 Topographic Map

A polyhedral projection is presented as a projection that meets the requirements for the topographic map. It assumes coverage of the curved surface of the country by a multitude of small tangent planes, constituting the surface of a polyhedron. All points were projected onto these small planes from a point of origin at the centre of the Earth. It shows that this projection is nothing more than a central projection (azimuthal; flat), gnomonic, of the type called polyhedral.

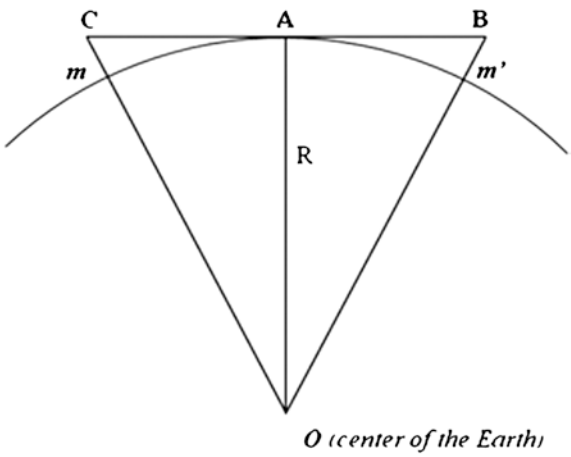
As the polyhedral planes cover an area of $30' \times 30'$, the curved surface of Brazil is replaced by a polyhedral surface on which each face corresponds to one sheet of the general map. It shows that errors from this projection would be minimal, and therefore do not need to be taken into account. Figure 2 shows the polyhedral projection.

Based on this design, and adopting the Clark ellipsoid of 1880, with the semi-major axis equal to 6,378,249 m, with a $15'$ tangent and a $15'$ arc, there would be an error of 0.255 m in the 55 km side length of the sheet (Menezes 1996).

2.5 Construction of the Map

The specifications for the construction of each sheet are presented in the study, showing that there would be no difficulty in implementing them, and that even at lower latitudes, the convergence of the meridians would be no more than 0.15 mm,

Fig. 2 Polyhedral Projection



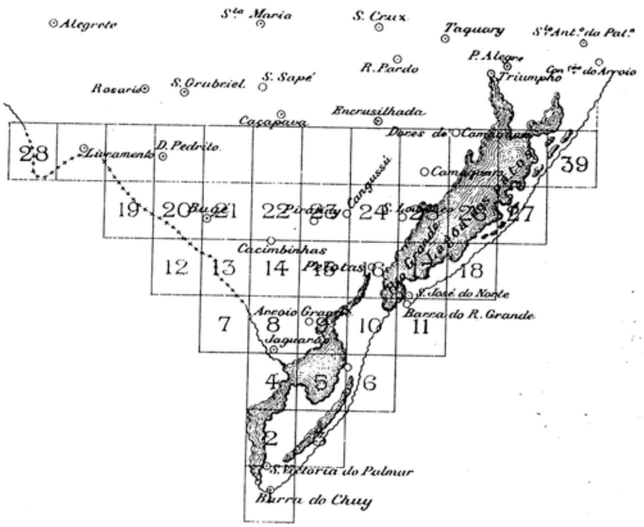


Fig. 3 Initial distribution of the sheets for the State of Rio Grande do Sul

Table 3 Comparison of other countries

Countries	Area km^2	Map scale	Higher scale	Sheet dimensions	Dimensions in meters	Number of sheets	Notes
Germany	539,813	1:100,000	1:25,000	$30' \times 30'$	0.278×0.336	674	1841
Italy	297,455	1:100,000	1:50,000 1:25,000	$30' \times 20'$	0.446×0.336	277	1869
Austria	674,662	1:75,000	1:25,000	$30' \times 15'$	0.49×0.37	715	1872
Brazil	8,336,393	1:100,000	1:25,000	$30' \times 30'$	0.65×0.60	+3,000	To be started

imperceptible to the user and negligible for the construction of the sheet. It also shows the ease of construction of identical tables for the latitude bands considered for the sheets. Figure 3 shows the distribution of the sheets for the state of Rio Grande do Sul.

The report also shows ways of indexing of the sheets, from 1:100,000 to 1:25,000, ending this section with the statement that Germany, Austria, Italy, Serbia, Spain, the United States and Japan had chosen this projection. It also presents a table comparing each of the above countries (Table 3).

2.6 Geographic Map

Regarding the specification of a geographic Map, it states that the role of the Army is to prepare only the topographical maps, but due to the existence of numerous studies showing the entire area of Brazil, it was decided also to specify the construction of a geographic map.

A study was undertaken on the types of deformation for a map of this scale, with the following conclusions:

- Regarding the projection, considering Brazil's position in relation to the equator and choosing an equal area projection, after a thorough study, Lambert's zenithal equivalent (also known as Lambert's zenithal equal-area) projection was chosen.
- Regarding the scale, it was decided to use the millionth scale, with a sheet size of 1 × 1 m, to fit in a small number of sheets. The area on the ground was defined by quadrangles of 8° × 8°.

This project is of a great technical merit, worthy of admiration today, because it is the result of the scientific culture of Brazilian army officers, especially in physics and mathematics. Unfortunately this project did not run at the standard that it could have attained between 1903 and 1918, when Brazil started a new and decisive phase in its cartography.

3 The Commission of the General Map of Brazil

On March 27, 1903 the Commission of the General Map of Brazil was created in Porto Alegre, Rio Grande do Sul, to start the implementation of the General Map of Brazil. The project began with the triangulation of Rio Grande do Sul, adopting the European model, which was intended to cover the State through a network of triangles, formed by three chains along the parallels of latitude and three chains along the meridians, separated by 1° 30′ in latitude and 2° in longitude (Castello Branco 1949).

The astronomical observatory of the Commission was also installed, and in the city of Torres a tide gauge was installed to provide the vertical datum for first order levelling. In the city of Santa Vitória do Palmar the first major invar geodetic base in Brazil was measured, with the length of 20,352.7609 m. Soon the guidelines of the work came to be influenced by the geodetic services of Germany and Austria, which were considered more suitable for carrying out the work.

The geodetic work continued until 1908, when it was pushed into the background due to diplomatic tensions arising with neighbouring Argentina. Chorographical sheets were prepared and, in spite of faithfully presenting the terrain, they were not controlled by the triangulation. However, the sheets of the Brazilian map, except for some sketches drawn around some cities, had not been prepared. However, precise geometric levelling was still taking place there, carrying heights over several large rivers, consolidating various topographic field processes, as well as developing astronomical control for the geodetic triangulation.

The Commission was later used in other studies of various kinds, and their activities were grouped into four well-defined periods. The first period, from its creation until 1910, was characterized by precise geodetic surveys, while at the

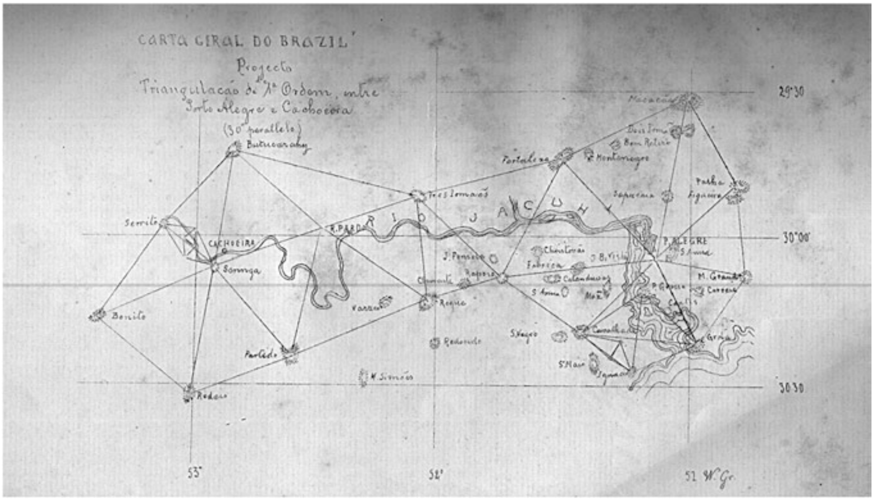


Fig. 4 Triangulation from Porto Alegre to Cachoeira (Fragoso 1904)

same time it began surveying around Porto Alegre. After that, strategic interests demanded that the Commission concentrated all its efforts on reconnaissance surveys between 1910 and 1916, which covered almost half the area of the state, being published in 53 sheets at 1:100,000 scale, in the $30' \times 30'$ format. The third phase developed regular surveys at 1:25,000 scale around the main cities of Rio Grande do Sul, covering a total area exceeding 4,000 km^2 before 1923. Finally, from 1923 to 1928, the main work was concentrated in the *Missões* region, between the Ijuí Ibicuí and Uruguai rivers, and the Santa Maria railway—Cruz Alta—Ijuí—Santo Ângelo, where the survey was carried out by regular tacheometry, at a 1:25,000 scale, of an area of about 20,000 km^2 (Coelho 1937).

There was much prominence given to the productivity of the Commission, however, the most remarkable aspect was the geodetic triangulation, due to the intensity and excellence of the accomplished works. The 1st order network of Rio Grande do Sul, considered to be one of the most extensive in South America, covers an area of more than 170,000 km^2, almost two-thirds of the State's area, executed with the most rigorous geodetic principles and technical precision. Figure 4 shows the triangulation from Porto Alegre to Cachoeira, extracted from the original Report of the General Map of Brazil (Fragoso 1904).

4 The Military Geographic Service

In 1913, the Military Geographic Service was created, with a section for stereophotogrammetry organized by the Major Alfredo Vidal, who maintained close contact with Prof. Carl Pulfrich, of the Geographical Institute of Vienna. Alfredo

Vidal who proposed the introduction into Brazil of stereophotogrammetry, was the organizer and first director of the Military Geographic Service. This proposal, though brought by the Army, was also accepted by the Registration Committee of the Map of the Federal District (Rio de Janeiro). The purchase of two von Orel Stereoautographs from Zeiss, Jena, was therefore authorized for work on both projects. At the same time, the engineer Emilio Wolf, an assistant of von Orel was invited to direct this work. Under the direction of Wolf, work was started in July 1914, with a survey conducted in Ilha do Governador, but was interrupted with his return to Austria due to the war. The stereophotogrammetry section saw practically no further activity, until the arrival of the Austrian Mission, on October 14, 1920. However, at the initiative of some officers, a survey was performed on the Military Village area, at a scale of 1:10,000.

Around the same time, there are reports that Captain Alipio di Primo, using a Sopwith Camel aircraft of the French Military Mission and a Palmos stereo camera, sitting in a box and pointing through an open hole in the fuselage of the aircraft, made a session of aerial photos of Rio de Janeiro. Despite these being the first aerial photographs taken in Brazil, they were only for interpretation, as they lacked sufficient photogrammetric structure. The first operator to take aerial photographs with the appropriate means was Major Eduardo Vallo, of the Austrian Mission, for the Map of the Federal District in 1920.

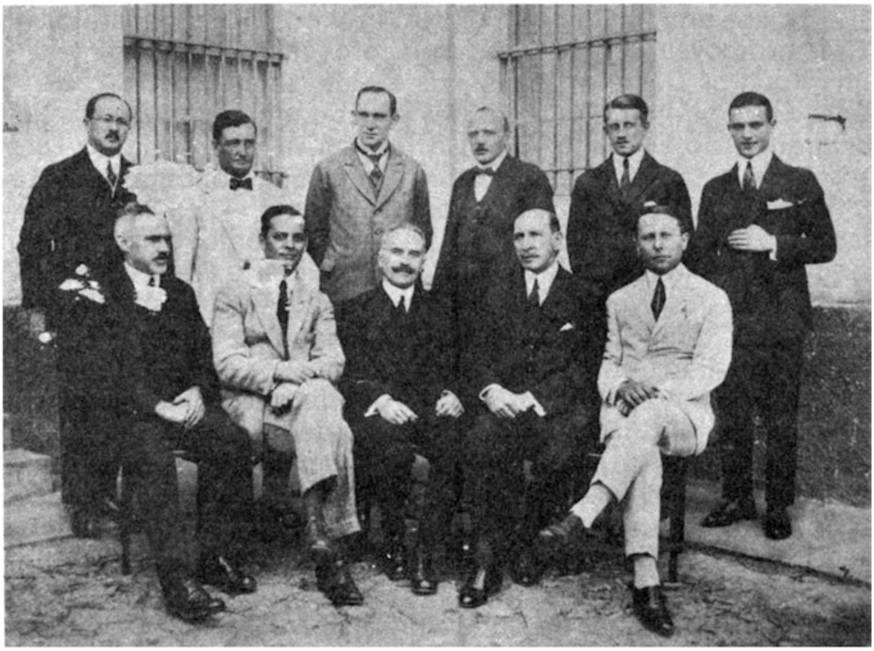


Fig. 5 Austrian Cartographic Mission—seat *left* to *right* Georg Winter, Emile Wolf, Karl Gaksch, Augusto Pokorny, Eduardo Vallo. *Standing* Rudolph Langer, Max Kolbe, Roshosch, Johan Autengruber, Adolph Jedlitschka e Wilhelm Winther (Brazilian Geographic Army Service)

In 1919 Alipio di Primo went to Europe with the mission of organizing the final stereophotogrammetric section of the Army. His mission was successful, leading to the Austrian Cartographic Mission arriving in Brazil on October 14, 1920, headed by General Doctor Arthur von Hübl, former director of the Military Geographical Institute of Vienna, which was an internationally recognized and respected organization. Figure 5 shows a photo of some members of the Austrian Cartographic Mission, taken in 1920 (Castelo Branco 1975).

The Austrian Cartographic Mission's objectives were to deploy stereophotogrammetric processes, aerial photography, terrestrial photogrammetry and offset map printing. However, the group performed many other tasks, along with officials from the Military Geographic Service, which permitted the definitive establishment of scientific cartography in Brazil.

The other components of the Austrian Military Cartographic Mission were as follows:

- Colonel Charles (Karl) Gaksch, Technical Consultant in Geodesy;
- Colonel Augusto Pokorny, Technical Consultant in Topography;
- Lieutenant Colonel Emile Wolf (Emile), Technical Consultant in Photogrammetry;
- Major Eduardo Vallo, Technical Consultant in Aerial Photography;
- Lieutenant Rudolf Langer, Photography Technology Assistant;
- The brothers Jorge (Georg) and Guilherme (Wilhelm) Winther, Photographers;
- Max Kolbe, Photolithography Technical Assistant, introducer of map printing in seven colours in Brazil;
- João (Johann) Autenguber, Printing Technical Assistant and
- Adolph (Adolf) Jedlitschka, First Class Map Designer.

Colonel Carlos Gaksch, was the oldest member of the Austrian Cartographic Mission. He was the organizer and technical advisor of the Office of Geodesy of the Geographic Service of the Army, a position he held for the twenty-six years that he lived in Brazil, until his death on 9 June 1946. At the School of Military Geographic Engineers (the origins of the Military Institute of Engineering—IME), he was Professor of Astronomy and Geodesy. Emile Wolf created in Brazil a stereoplotter, simple and low cost, the Wolf Stereograph.

With the presence of the Austrian Mission, the Army created the Military Geographic Service, with headquarters in the Fortaleza da Conceição. The first mission was the planialtimetric Topographic Survey of the Map of the Federal District (now Rio de Janeiro), which, printed in seven colours, would become one of the maps to commemorate the first centenary of the independence of Brazil.

From the original scale of 1:50,000, new scales at 1:20,000, 1:10,000 and 1:2,000 were developed, serving as a basis for tactical instruction in the School of Improvement of Officers.

The Austrian Mission had the task of the studying the map projections suitable for mapping the national territory, and which led to the adoption of the Gauss-Krüger system, with projection in bands of 3°, later extended to 6°.

Stereophotogrammetric work became common during this period, with surveys of virtually the entire national territory being carried out between 1923 and 1932, together with the work of the newly formed National Committee for Geography, for the development of networks of levelling and triangulation of Brazil.

In 1932, the situation of the Military Geographic Service was that of a regional body, acting in the Federal Capital and the State of Rio de Janeiro, while the General Map Commission developed small projects in southern Brazil. At that time, Colonel Alipio di Primo promoted the merging of both organizations and by the Decree 21,883 of September 29, 1932 the Military Geographic Service was renamed as the Army Geographical Service (SGE). It had a new administrative structure, composed of a Board, four technical divisions, Geodesy, Surveying, Photogrammetry and Cartography, Administrative Division, 1st Survey Division, based in Porto Alegre, and 2nd Survey Division, based in Rio de Janeiro. In this way the survey work of the Brazil started to be actually implemented.

Parallel to the development of topographic cartography, there was also an ongoing development of the Geographic Map of Brazil at a scale 1:1,000,000 at the Engineering Club. Its studies were initiated in 1908, but implemented in 1916, under the guidance of Doctor Francisco Behering, who was responsible for organizing the instructions according to the resolutions of the International Map of the World, held in London in 1909. The two surveys were completed as part of the celebrations of the centenary of the independence of Brazil in 1922 (Castello Branco 1978).

5 Conclusions

This work presents the beginnings of scientific cartography in Brazil. After this period, the survey operations, both topographical and geographical, were definitively deployed nationwide. The Board of the Military Geographic Service continued, with the creation of other survey Divisions, acting in specific areas. On the other hand, the National Council of Geography merged with the Brazilian Institute of Statistics and also started to carry out surveys and topographic mapping in the Country.

The country has a duty to express its thanks to the then Austrian Cartographic mission, without which the implementation of stereo aerial photography would probably have been postponed.

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Paulo Márcio Leal de Menezes is a surveying engineer who received his M.Sc. in Computational Systems and Automated Cartography from the Brazilian Military Institute of Engineering in 1987. His D.Sc. in Geography was obtained from the Federal University of Rio de Janeiro in 2000. Professor de Menezes is currently Senior Professor of Geography at the Federal University of Rio de Janeiro and Head of the Cartography Laboratory at the same institution. He has published one book, five chapters in books, 18 papers in scientific journals, and 148 conference papers and seminar proceedings. His research interests are Digital Cartography, GIS, Historical Cartography, Web-Cartography, and Thematic Cartography.

Part IV
General

Cartographic Commentaries and Map Descriptions of the 19th Century as Historical Sources

Alexander Schunka

Abstract Drawing upon Claude Lévi-Strauss, historian Peter Burke has described as 'information' "what is relatively 'raw' …, while 'knowledge' denotes what has been 'cooked', processed or systematized by thought." This essay argues that cartographic commentaries provide an important link between 'raw' information as collected by geographers, cartographers or travellers, and its condensed form provided in maps. Since the early modern era, most maps were accompanied by commentaries, explications, or descriptions. In the 19th century map descriptions became increasingly valuable, in particular because maps gained a wider audience among scholars and the broader public. These descriptive texts have long been neglected by historians and geographers alike. Based on the numerous commentaries printed in *Petermann's Geographische Mitteilungen*, the most renowned German-speaking geographic periodical of the 19th century, the essay argues that commentaries illustrate the contemporary meanings of a map as well as the decision-making process behind its production. They not only offer insights into the cartographer's choice of scholarly information, but also include rhetorical strategies and aesthetic categories in order to familiarize readers with a map and with more or less exotic regions. Furthermore, they provide information on expectations and strategies of publishing a specific map at a particular time. Cartographic commentaries include hopes of how a map should be used in the future, illuminating geographical and environmental world views and imperial strategies, ethnocentrist concepts as well as economic aspirations. Not only do they link text and image, but they also connect maps with the history of global knowledge and expansion.

1 The Case of the Ice-Free South Pole

The 26th installment of *Stielers Handatlas*, one of the most renowned atlas works within the German-speaking world of the 19th century, appeared in 1863 containing a map of the "South Polar Regions". This map was the first of its kind and for

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this reason it required an explanation. August Petermann (1822–1878), the leading figure of the famous Perthes publishing house based in the German city of Gotha, provided the explanation in the form of a detailed commentary to the map. The commentary was printed in Petermann's journal, the *Geographische Mitteilungen* (Petermann 1863: 407–528). According to Petermann's commentary, a special feature of the projection format employed by the map was to be found in the way the distances between the southern tips of the continents and the pole were less distorted than what would have been the case with the standard Mercator projection. In terms of its contents, the map and the commentary were based largely on the reports of explorers, beginning with James Cook. Petermann emphasized how insufficient the current knowledge still was when it came to Antarctica. In this regard he conceded that this new map was evidently anything but perfect and definitive. This had to do in large part with the numerous contradictions between reports from the individual expeditions. At locations where some explorers had encountered insurmountable barriers of ice, others had described an open ocean.

"It could be argued," said Petermann in his commentary, "that such a map possesses little interest and consisted of a white sheet of paper adorned with some vague information and therefore was not necessary within an atlas" (Petermann 1863: 407). He was adamant that this was however a very superficial point of view because in actual fact the map was incredibly important on the basis of its innovative character and the comprehensive nature of the available information it presented. It was furthermore informed by a specific hypothesis: Petermann presumed that surrounding the South Pole there were some islands but no large land masses and certainly not a continent. He imagined that at the pole there was open sea. The Gotha geographer had already made a name for himself with his theory of an ice-free north pole. There was, therefore, a certain logic to extending this view to the area around the south pole, even if in this case Petermann relied less on hydrographic and meteorological calculations and more on accounts brought back from expeditions (Felsch 2010: 102–115). His crown witness for the theory of an ice-free south pole was the British explorer James Weddell whose journey of exploration in 1823 at 74° southerly latitude encountered a navigable sea, pleasant and mild weather, numerous whales and extraordinary flocks of birds (Petermann 1863: 409).

In his commentary on the map, Petermann rejected with supreme confidence all contrary reports in which his contemporaries posited a barren, icy mass of land at the South Pole. Instead, he unequivocally asserted his belief in a polar region whose mild climate offered excellent opportunities for exploitation and settlement as soon as one had broken through the obstructing pack ice. The southern Shetland Islands lay for example at the same latitude as France and Italy, but their climate was much milder than that of the corresponding European countries. The Kerguelen Islands were half as large as the Prussian Rhine province and at the same distance from the Pole. In contrast to the Rhine province however, they were completely uninhabited. The Azores in the northern hemisphere were a "small paradise" which supplied Europe with tropical fruit. By comparison, the potential islands at the corresponding southerly latitudes had unfortunately not been tapped at all (Petermann 1863: 420).

Petermann was undoubtedly not concerned about objectivity in his overview of the available information. Rather, he was pursuing a definite goal. His guiding interest was only partly the status of Antarctica as one of the last problems for geographical research. More significant for the Gotha cartographer was the fact that the most important global shipping and trade routes passed in relative proximity to the South Pole. This testified to his opinion of the eminently “practical importance” of this region at this point in time. But this was not all. What else could be expected and hoped for in the future? According to Petermann, the Europeans in the 19th century had finally prodded the southern parts of the globe from “their slumber.” This could be observed in the case of the Cape Province but also in the case of Australia and New Zealand, the “Great Britain of the South Seas.” It was only necessary to push the popularity of the South Pole in order to generate greater interest among people from the North for its potential exploitation. This would then pave the way for a glorious future. One could consider whaling and sealing operations, and the export of guano which provided a state such as Peru with riches. Natural resources were possibly awaiting discovery. But most of all arable land could be tilled and ploughed. In comparison to Africa, the exploitation of resources at the pole would be a simple matter as there would be no disturbance from stubborn natives. Nevertheless, “boldness and tenacity” were required, and these virtues were to be found first and foremost among the numerous Germans living in or migrating to Australia (Petermann 1863: 416, 410, 425, 427).

Petermann had reserved a special role for German scientists in Australia when it came to opening up Antarctica. This fact is of little surprise if one takes into account the situation of German scientists on the fifth continent and in general the significance which immigration to Australia had in Germany around the middle of the 19th century (Fischer 1991; Voigt 2010). The *Geographische Mitteilungen* from the Perthes publishing house took a special interest in demography and issues of migration. Petermann’s friend and collaborator since the 1840s was the German-born geographer Ernest Ravenstein who lived in London and who was not only engaged in the thematic mapping of demographic problems, but is also considered one of the founding fathers of migration studies (Grigg 1977; Kirchberger 1999). The *Mitteilungen* often reads like propaganda encouraging overseas emigration and, in particular, participation in the Australian gold rush (Petermann 1855a, b: 346; Behm and Hanemann 1873: 418). Because the excitement caused by gold was however subsiding around 1860, the German-Australians could now, according to Petermann, turn their attention to cultivating the land in the southern polar region. The geographer justified this on the basis of the proximity to Antarctica. With a suitably equipped steam ship the potential settlers would arrive there in no time. Petermann calculated that a journey of 10–20 days was required to traverse the distance from the Australian coast to the pole (Petermann 1863: 424, 427). He did not ask about the reasons why no one else had until then seized upon the idea to settle Antarctica.

The remarkable thing about the commentary to this map (like many such other texts) is that the ulterior motives which had prompted Petermann and the Perthes publishing house to produce and publish the map of the south pole are hardly discernible by simply looking at the map. If one however reads Petermann's commentary in conjunction with the map and if one reads this commentary "against the grain" (Mohrmann 1991) in line with the methods of historical anthropology, then the intentions, expectations and hopes associated with the map become clearer. The commentary to the map provides the key in identifying the visions and future perspectives projected onto the map and in appreciating the pre-conditions which we from our current perspective need to fulfil before we can begin to understand the map and the context of its genesis. Petermann's commentary also illustrates in this regard how it was possible in the middle of the 19th century to generate the interest of a non-specialist audience in the cartographical representation of a distant part of the world and to thereby enhance the receptivity on the part of the public for such information (and increase also the marketing potential of particular maps). Furthermore, an appreciation emerges for the rhetorical strategies which suggested proximity and familiarity, for example, by comparing unknown islands in the south polar sea with the Azores and the Rhine province, or by describing hospitable, fertile tracts of lands, by praising German dynamism on the fifth continent and by evoking explorers who bravely bored their way through the ice.

2 Methodological Considerations

The following discussion focuses on the commentaries which Petermann and his collaborators provided for the maps published by Perthes in Gotha. It treats these commentaries as a specific genre of source materials and proposes various possibilities for their evaluation. These reflections can be seen as a probe exploring a topic which has been neglected both generally by historians and more specifically by cartographical historiography (as an exception: Schelhaas and Wardenga 2007). The point of departure might seem somewhat banal—that without these commentaries it is difficult to comprehend why a map was produced at a certain time, why preference was given to certain information, what statement was implied by a map at the time of its production or publication, and what mental dispositions but also long-term intentions and strategies motivated the production of the map in the first place.

Within the evolution of western literature, commentaries have a long tradition as explanatory and/or advertising devices (Häfner and Völkel 2006; Ajouri et al. 2009). At least since the early modern era, printed commentaries usually aim at enhancing the understanding as well as the acceptance of a particular product among its recipients. At the same time, the commentator claims for himself a particular interpretive authority over his readers. A commentary is therefore never an unbiased piece of 'truth' but always presents a subjective and intentional opinion or interpretation in regard to readers' expectations as well as bears a strong potential of manipulating them (Bellingradt 2011: 16).

The significance of map commentaries in understanding cartographical projects, in appreciating the function and use of the map and in correctly extracting the relevant information was already clear to Petermann's contemporaries. This is evident in the effort which the authors in Petermann's *Geographische Mitteilungen* invested into these commentaries. But voices from related disciplines such as general history affirmed the importance of the genre. The historian Heinrich von Sybel, for example, the founder of the most prestigious German-speaking journal in history (to this day), the *Historische Zeitschrift*, and a guest author in Petermann's *Mitteilungen*, stressed in 1873 that the value of a map not only resided in the "collected material" which was presented in the appropriate graphic form but that it was the "literary form" which established the accessibility of such a map (Sybel 1873: 83–84; Dotterweich 1978).

Map commentaries take up much space within Petermann's *Mitteilungen*: they refer to maps which appeared in the journal on extravagant inlays in colour or which were published in parallel in other Perthes products, such as the above-mentioned *Stielers Handatlas* or in individual publications. In addition to this the cartographical products of competing publishers were discussed which could sometimes make the commentary and the critical review indistinguishable. The authors of these commentaries were the Gotha-based cartographers—such as Petermann or his important collaborator Bruno Hassenstein (Demhardt 2006: 71–72; Ratzel 1902)—but often also the explorer whose measurements, reports and sketches had provided the basis for the cartographical work. Far from being a unique speciality in Petermann's *Mitteilungen* or of the Gotha publishing house Perthes, such commentaries were a standard feature in geographical periodicals of the time. Admittedly, the commentaries produced in Gotha undoubtedly belong to the most elaborate within this text genre.

In the framework linking the production of cartographical knowledge with the emergence of distinctive worldviews, the commentary fulfilled a special mediating role. It lay at the decisive point of intersection between the gathering of information (either directly at the location or from other maps or literary texts) and the next step in which this information congealed to a cartographical form of knowledge as presented in the completed map. In addition to this, the commentary provided the justification for drawing upon certain sources of information and deliberately ignoring others. The commentary thus provides information about the process of producing the map. Furthermore, the commentary yields insights into the disposition and intentions of the author, explorer and cartographer. This enables us to draw conclusions about the social knowledge (Schunka 2000: 16–17) of map producers and the political-social context in which the map and the cartographical knowledge emerged and which the commentators in turn might have influenced as a result of their use and their interpretation. The commentaries on maps are thus a communication medium generating social meaning and also containing reflections about this very process (Giesen 2004).

In this regard the commentaries on maps are located at the interface between information and knowledge—in a certain sense between the "raw" and the "cooked." This differentiation has established itself since Claude Lévi-Stauss as a central component of anthropological thought (Lévi-Strauss 1964). It was then transferred by Peter Burke to the history of early modern communication and media. According to Burke, information represents "what is relatively 'raw,' specific and practical, while 'knowledge' denotes what has been 'cooked,' processed or systematized by thought." This differentiation between "information" as something "raw" and "knowledge" as something "cooked" has been made fruitful for the history of information in the early modern period (Burke 2000: 11; Brendecke et al. 2008). It can however be extended to the production of cartographical knowledge. In this regard, map commentaries occupy a position between the experiences of the traveller or the information which he channels back home, and the knowledge which is consolidated in the form of a map. The cartographers of the 19th century knew full well that such cartographical knowledge was arrived at by abstraction and interpolation. If even the producers of maps could not be sure about the inner regions of Western Australia or of Antarctica then they had to rely on guesses and presumptions which were not immediately recognizable as such when graphically presented on a map. The steps in arriving at educated guesses, the preliminary considerations and the intentions of the cartographers, can hardly be extracted from the map alone (Monmonier 1991: 58–70). This is where commentaries can be of invaluable assistance.

The commentaries directed the attention of map readers when their producers could not fully feel confident in relying upon the cognitive proficiency of their prospective audience. There is no doubt that map commentaries were developed to increase the legibility of maps and to enhance their practical utility: as instructions or a "recipe" but increasingly as a report from the workplace of the explorer or cartographer in order to stimulate scientific discussion and to advance knowledge. Obviously such a discursive medium could serve the commentator or the cartographer in their attempt to stylize or fashion a certain image of themselves (Greenblatt 1980; Harley 2001: 38). In this regard, caution is necessary in extrapolating directly from the commentaries to the intentions of the cartographers—undoubtedly an eye must be given to the strategies employed in pursuing them.

In what follows, Petermann's *Geographische Mitteilungen* will be used to explore the analytical possibilities contained within map commentaries. The present essay will therefore deal with their intentions and arguments, with the justifications for presenting new maps, the possibilities of popularizing information, the expectations with regard to the receptiveness for certain maps and the reflections that accompanied all of this. The focus will be upon the political, economic and social background within which one must situate the commentaries, the maps and their producers, but also on the manipulative strategies pursued by the commentators and deriving from their contemporary context. A general thesis might state that maps are founded upon hopes and expectations, upon visions and chances. Aspects pertaining to repeatability, revisability and an orientation towards the future are intrinsic to graphical representations in the form of maps (Schlögel 2003: 86–87, 152–153). Maps aim at repeatability in the sense that they make an area accessible on repeated occasions regardless of whether we are dealing with the traveller who is already physically in the region with the map in hand or considering a journey while still at home. They are oriented towards the future because they present documentation about what has been achieved and reached in the past by an explorer who undertook the trials and tribulations of the journey and invested the time and effort into documenting it in the expectation that others would later find it useful and interesting. Scientific recognition and the economic rewards can only be expected when a map can make a convincing case for its future relevance. Similar to cooking recipes, map commentaries document on the one hand the processes by which they were produced, while, on the other hand, they are geared towards repeated use and further development. In a fashion similar to cooking recipes, they aim for the future reproduction of a specific process and do not simply document a unique, one-off event already lying in the past. Commentaries to maps offer therefore strategies for arguing about the plausibility of future action, expectations, hopes and possibilities (Koselleck 1992: 349–375; cf. Grimm 1893: 852).

3 The Development of the Map Commentary

There seems to be a consensus within the recent research into historical cartography regarding the claim made by John Brian Harley that maps are to be understood as texts (Harley 2001; Schlögel 2003: 96–107). It is in any case true that most current or historical maps do indeed display components of written text which are more or less closely linked to the graphical image of the map. In terms of form and context, the headings, cartouches, legends, captions or dedications stand in a direct relationship with this image (for numerous examples see Woodward 2007; Harley 2001: 51–81). Research into the medium of maps attempts to do justice to this situation by speaking of an integrated system of signs or a hybrid of text, image and symbol (Stockhammer 2007: 12–18; Würgler 2009: 117–118). By comparison, texts which belong to a map but supposedly stand for themselves have received less attention than the textual elements which are part of a map. However, when seen from a historical perspective, such texts are hardly anomalies.

Early cartographical representations often display a distinctive narrative structure, especially when one thinks of the itinerary maps of medieval times (Hermann 2000). Autonomous adjunct texts had at first a loose connection to the maps, as for example in the *Catalan Atlas* of the 14th century (Black 2005: 34–37). However, there seem to be changes at the beginning of the modern period when it comes to the relationship between maps and the texts accompanying them. The Protestant maps of the Holy Land, for instance, even served the understanding and appreciation of textual material such as in this case the Bible (Meurer 2007: 1216–1220). From the 16th century onward an intensified interplay of maps, texts and inspection can be observed in legal matters or in connection with the need to survey and demarcate territory (Friedrich 2008; Black 1997: 6–7; Stockhammer 2007: 29–49). At the same time, maps begin to play a large role in various publications even when they are not directly concerned with matters of a geographical nature.

Explanatory commentaries which do not directly constitute part of a map but nevertheless refer to the graphical image began to appear in the course of the early modern period, particularly in atlases. In this manner, the famous *Theatrum Orbis Terrarum*, which was produced by Abraham Ortelius in 1570 and merits recognition as the first atlas in the modern sense, contained detailed accompanying text on the back of each map. These texts can be placed within the context of Renaissance antiquarianism and early modern chorography in the sense that they stimulated the discussion and surveyed the field of ancient and contemporary knowledge about countries and the seas. They are thus replete with biblical references, but also with myths and legends. At the same time, the commentaries provide instructions for future journeys, warnings about the concomitant dangers as well as advice about the potential exploitation of those regions represented—for example where there is mention of climate, fertility and agricultural cultivation (Broecke 2005, 2009; Friedrich 2003). This also applies for the texts within the atlas produced by Gerhard Mercator in 1595, a work closely linked to Ortelius' *Theatrum* (Mercator 1595).

From the early modern era onwards, cartographic commentaries do not always seem to relate directly and in every aspect to the map they aim to describe and explain. It might even appear that these texts sometimes correspond only rather vaguely to it, depending on contemporary cultural imprints, on a possible self-explanatory character of a map, but also in relation to the specific goals (and the creativity) of a particular commentator at a certain time. In the decades following Ortelius and Mercator, for instance, the usual pieties paid to ancient or biblical authorities which had long been the order of the day, receded ever more. The functions performed by map commentaries remained however intact. The growth of knowledge about the world and the innovations in measurement and in techniques of projection resulted in maps more closely related to a scientific or academic context and requiring explanations which prevented misunderstandings and ensured the future use of the map. In the 17th and 18th centuries the study of history, then in the process of liberating itself from theology, was an important source of orientation in the interpretation of maps. The English bishop Peter Heylyn who was active both as a historian and geographer ascribed to geography the task of building bridges to theology but even more to history: "Geography without History hath life and motion, but very unstable and at random; but History without Geography, like a dead carcase, hath neither life, nor motion at all" (Mayhew 2000: 34; Milton 2007). In this regard, the map commentaries in Herman Moll's *System of Geography* from 1701 primarily had a historical and political orientation—the represented region was defined in accordance with the stipulations of history and applied geography. Little reflection was given to the map itself and the process by which it had been produced (Moll 1701).

A few years later, when a conspicuous commercialization in the production of maps had emerged in England, this was felt to be a deficiency. The geographer and cartographical theoretician John Green was vehement in the criticism contained within his *The Construction of Maps and Globes* (1717) when it came to the extant geographical works which in his opinion were essentially works of history. He demanded that geographers break their silence in the face of imprecision and, instead of trying to hide inaccuracies, reflect upon the reasons why they existed. A fundamental mistake of geographical research lay in the habit to adopt second-hand information without flagging it by way of a proper commentary. Ideally, the geographer "should be very exact in giving a Description of his MAP, for as a MAP is (or should be) the true Representation of a Country in a Geographical Figure or Draught, so the Geography (abstractedly taken) is only to describe that MAP after an exact and methodical manner. […] In composing the Work no Remark should be inserted without citing the Author, to the end, that the Reader may the better judge of the Geographer's Pains, and what Credit is to be given to everything that is related". (Green 1717: 166–167. For the context 158–167).

What can be seen as a product of the methodological differentiation inducing an ever more marked delineation between geography and cartography can also be correlated to the need for map commentaries. Ideally they gave consideration not only to the area illustrated by the map but also to the conditions under which the map was produced and the material upon which it drew. Only then could the needs of a future, potential user of the map be satisfied, according to Green. Questions of marketing and a target audience—Green insisted that a map should be primarily "useful to a Traveller" (Green 1717: 166)—created the conditions under which a more decisive and distinctive function was accorded to the map commentaries. The need for reflection upon the sources of cartographical information was associated with fundamental shifts in the sciences which became more geared towards empirical research and to a critical assessment of the historical documents.

Numerous sources in the 18th century also influenced the production of maps and commentaries. This "century of journals" was witness to a growth in the periodicals devoted to themes such as travel and geography, and this was paralleled by a broad popularization and commercialization of information about foreign lands (Würgler 2009: 43–49; Griep 1999; Rousseau 1990). These developments culminated in the great geographical-cartographical periodicals of the 19th century in Germany such as the *Allgemeine geographische Ephemeriden*, which was published in Weimar from 1798 onwards under the editorship of the Gotha astronomer Franz Xaver von Zach (who was also the teacher of the distinguished German mathematician Carl Friedrich Gauss) as well as, somewhat later, Friedrich Justin Bertuch (for Zach, see Brosche 2009; for geographical periodicals in the 19th century, see Wardenga 2008). The maps within the *Ephemeriden* were accompanied by commentaries, not least because this journal was meant to be understood as a forum of scientific discussion promoting the improvement of cartographical standards (Einleitung 1798: 15–16, 54–55). The rise of the publishing house of Justus Perthes in the neighbouring city of Gotha from the early 19th century onwards was also closely connected to the success of another journal which in turn reflected the development of the press in these decades: the *Gotha Almanach*, a famous, annually published directory of the European nobility. An awareness of these roots of the Gotha publishing house within the contemporary history of scholarship and press around 1800 remains discernible not only in the impressive Perthes archives in Gotha (still extant today, Weigel 2011) but also in Petermann's *Geographische Mitteilungen* until well into the 19th century (Geschichte 1862. For the context Brogatio 2008; Köhler 1987).

In addition to the popularization of science and the development of the periodical press, the growing military need for accurate maps towards the end of the early modern era stimulated reflection upon a particular backwardness of German cartography in comparison with Western European rivals. Thus in a textbook on triangulation of the 1790s the Saxon cartographer August Gottlob Böhme reflected upon the need for map commentaries especially in regard to military cartography. He stressed his view that not all the topographical and geographical peculiarities of relevant areas could be adequately represented on a map: "for this reason one needs to include a separate text or a table, in which account is given of all these features." (Böhme 1793: 200).

If one considers Petermann's *Geographische Mitteilungen* in the context of the other geographical and cartographical periodicals of this time, then it becomes apparent that the map commentary was an established feature by the 19th century. It was a medium which went beyond a mere explanatory appendix by providing interpretation and furnishing information about the motives of the map's producers and their hopes and expectations for its future use. In addition to this function of informing and entertaining a scientifically curious audience, the commentaries sought to bolster the utility of the map for future travellers, explorers, scientists, merchants and entrepreneurs as well as politicians and men of the military. Geostrategic aspects were a feature as well as considerations pertaining to the degree in which concrete actions might be planned and repeated. It is obvious that the map commentaries as well as the maps themselves and their textual elements not only illustrated the political and social power configurations but also generated them (Harley 2001).

4 Hopes and Expectations: Map Commentaries from the Perthes Publishing House

As has been illustrated above, map commentaries of the 19th century offer information about the work done by the cartographers. They legitimize this work and document the expectations with regard to the map's utility and hopes for its future use. But what concrete forms of legitimacy, what expectations and hopes can be distilled from the commentaries in Petermann's *Mitteilungen*? The following sketch is restricted to the first thirty years of the journal, from the 1850s to the 1880s. Five thematic areas need to be differentiated: firstly the diffusion and popularization of scientific knowledge, secondly (geo-)political visions, thirdly economic expectations, fourthly social and demographic opportunities, and finally considerations relating to the sustainability of natural resources and the provisions required to ensure a long-term future for a particular project.

In the opinion of the above-mentioned historian Heinrich von Sybel, a distinguished guest contributor to Petermann's *Mitteilungen*, maps should present to the educated reader not only the state of things as they presently stand, but also encourage the expert to engage in future research by revealing in the map commentary the degree of reliability pertaining to each piece of information

(Sybel 1873: 83). When one reads the commentaries in Petermann's *Geographische Mitteilungen* in the context of conveying and popularising scientific knowledge in the 19th century, then it might be surprising to find that the expansion and advancement of knowledge is only implicitly present. Engaged scientists such as Bruno Hassenstein might emphasize the "curiosity of the geographers" (Hassenstein 1863: 178) and the value attached to the investigation into specific, often remote regions, by for example pointing out the significance of the Kerguelen Islands for astronomical research (Petermann 1875). For the most part, the hope for gains in knowledge was a side product of projects driven by more pressing motives: in the commentary to a map of the Anatolian part of the Ottoman Empire one reads that an advancement of knowledge can only be expected for those areas which will be made accessible by the planned railway construction (the future "Bagdad-Bahn"). Particularly for maps of central Europe, the connection between a popularization of science and the development of areas for tourism plays a discernible role, as is the case for the Alps (Rezension 1883: 191). Elsewhere, such as in a map of East Sudan, European engineering ingenuity and expeditions into the wild entered into a cartographical and narrative symbiosis: one emphasized the degree to which the expedition routes and thus the production of maps depended upon the course followed by the already existing telegraph lines (Hassenstein 1881). Aside from these specific cases, a commentary often declared how singular, innovative or valuable a map was when it was presented for the first time to a larger audience. The popularization of academic research for a larger public is evident but is seldom explicitly articulated.

Political hopes and visions are however more frequently and more explicitly the subject of the commentaries. Thus, the geographer Friedrich Ratzel emphasized in a contribution to Petermann's *Mitteilungen* in 1885 that when it came to Africa a proper map of the "dark" continent would have to display its far greater political dynamics because the indigenous state formations and their, according to Ratzel, more flexible borders, could not be compared to European understandings of statehood (Ratzel 1885). Geopolitical images and expectations are stated in the map commentaries even more overtly than in the map images. In a commentary to a map of the German colony of "Deutsch-Südwestafrika" (Namibia) the clarification of the borderlines to the neighbouring British colony played an important role as the commentator ascribed to these questions a great political significance for the future. And when a map of Haiti appeared in Petermann's publication in 1874 (against the background of the ever more open imperial interest taken by the United States of America in the Carribean), the commentary contained the following remarkable appraisal: "This island can only be saved from its state of destitution by a foreign power. A fresh injection of life needs to occur. […] Whatever the future might hold for Haiti, we will for our part greet all endeavours which direct their attention to this geographical 'raggamuffin'" (Koffmahn 1874: 323. For the context Schmidt 1971).

It would be worthwhile to examine more closely not only how geo-strategic and imperial interests are mirrored in the map commentaries but also what effect journals such as Petermann's *Mitteilungen* and, in particular, the commentaries had upon geo-strategic thought and action during this period. To what degree did such periodicals contribute to creating particular facts, influencing 'public opinion', and even generating certain political realities? This relates admittedly to not only the political but also to the economic expectations which were formulated there. Economic considerations occupy a prominent position in the commentaries to Petermann's maps—one recalls the introductory example of the plans for opening up Antarctica to economic development. The hopes which were awoken in German cartographers (and the potential audience for their maps) by the planned railway construction through the Ottoman Empire were also reflected in the map commentaries. A further characteristic example for the insight into the way commentaries were interwoven with economic and strategic expectations comes from 1862 (Petermann 1862a, b). In this year the Perthes house published *Four Special Maps* as another supplement to *Stieler's Handatlas*. One of these four maps shows the North Italian "Quadrilatero" (Quadrilateral), a defensive system consisting of four fortresses south of Lake Garda (Mantua, Legnago, Peschiera and Verona), another the Straits of Gibraltar, the third the Isthmus of Panama and the fourth the Fiji Islands. The corresponding commentary was again printed in Petermann's *Mitteilungen*, as had become usual for the maps of the *Stieler Atlas*.

At first sight, it is not apparent to the observer of the maps what the North Italian "Quadrilatero", Gibraltar, the Isthmus of Panama and the Fiji Islands had in common and what justified such a publication. If one disregards possible contingent factors connected to house-internal matters then a certain pattern can be discerned thanks to the map commentary. This commentary emphasized not only the general geostrategic significance which these four areas shared and due to which these regions provided especially forceful reasons for their cartographical representation. In addition to that, its author Petermann insinuated another relationship. This was linked to the significance of Australia as a destination for German immigrants and as a backdrop for their economic aspirations. The area of the North Italian "Quadrilatero" and the Straits of Gibraltar were described with a view to the strategic role in military matters but also in their functions as regions to be traversed. What was being aimed at was even more apparent in the description of the Panama Isthmus which since 1855 was crossed by a railway line. The railway enormously shortened the transfer across the Americas for peoples and goods heading from Europe to the Pacific or vice versa. The Fiji Islands for their parts were in the process of being established as a military base and trading station for the British. The map commentaries described especially Panama and the Fiji Islands as ever more important locations in the network of trade, transport and communication with Australia. All of this was buttressed by aesthetic considerations relating each of these four locations. Sometimes, there was a marked discrepancy between the beauty of the landscape or the strategic importance on the one hand and the disposition of the inhabitants on the other. Thus, with regard to the Fiji Islands, one reads: "This island paradise is inhabited by people who number among the most atrocious cannibals and barbarians in existence" (Petermann 1862b: 262–263). This could be deemed as blood-curdling entertainment for the German reader interested in distant regions of the world—but possibly also as a warning for those travelling to Australia who undoubtedly were among the eager recipients of information regarding conditions of travel to the fifth continent, even if the immigration to Australia had begun to ebb at the beginning of the 1860s. The discrepancy between European visions of beauty and utility on the one hand and the inhospitable and obnoxious natives on the other can also be found in Petermann's commentary to the Antarctica map discussed above. It hints at the discursive consolidation of power relations manifest in the map commentaries. The rhetorical connection between what was wild and what was familiar, between the periphery and the centre, between idealistic hopes for the future and economic or demographic problems of the present was absorbed into the map commentary which drew an imaginary line from the Fiji Islands and Panama to Gibraltar and northern Italy.

Demographic questions were, particularly in the years after Petermann's journal was founded, a recurring topic—potential emigrants must have constituted a considerable portion of the journals' audience. Insertions devoted to the practical aspects of immigration appear frequently: for example, one finds discussions about opening up the gold fields in Australia, about the Australian climate or viticulture or generally about emigration to the fifth continent or, for example, to Uruguay or the United States (For emigration to Australia, see above. For Uruguay, see Uruguay 1855). A new map of North America was therefore supplemented with the relevant demographic information in a commentary which particularly pointed out the areas which were thinly settled or where there had been the settlements of earlier German immigrants (Petermann 1873a, b). The commentary on a map of South-East Australia took note of the numerous Germans involved in opening up the continent, described fertile river valleys which "despite their natural assets remained largely unsettled," while "being able to sustain a far larger population than, for example, the Blue Mountains in New South Wales." Australia was according to the author of the commentary "still in its infancy with regard to development and provided for the foreseeable future space for the overflowing populations of England, Germany and China." (Behm and Hanemann 1873: 418).

The map commentaries presented here allow a glimpse of the horizon of expectations and future hopes which informed the outlook of August Petermann, his collaborators and the readership of his journal. Part of this horizon of expectations was created by reflection about the natural resources whose exploitation was a precondition for the lives of Germans in the corresponding areas and for the future prosperity of Germany as a whole. The interest in certain topics can be seen as contributions to a discussion about exploiting and sustaining resources. What distinguishes these reflections is the perspective for securing and shaping the future at a time which was experienced by people in terms of accelerating change (Rosa 2005; Osterhammel 2009: 126–128; Koselleck 1992; Hölscher 1999; Uerz 2006: Ch. 3; Finzsch 2001; Zwierlein 2011). Map commentaries shed light onto the practical questions associated with this experience of acceleration. This is expressed in the thought experiments pertaining to opening up these resources to long-term utilization—a complex of problems which can be subsumed under the general heading of sustainability. Sustainability was closely linked to ambitions geared to attaining greater power and to the creation of reserves of resources for the future, but it also provoked thought about concomitant dependencies (Radkau 2002: 39, 436–437; Winiwarter and Knoll 2007: 302–309). Maps and especially map commentaries can be seen as constituting a medium for discourses revolving around sustainability.

The hope of opening up new resources was an important impulse stimulating geo-political visions at the end of the 19th and in the early 20th centuries (Osterhammel 2000). This pertained to natural resources but also to spheres of political influence and areas for trade and settlement. In the eyes of Petermann and his contemporaries the desire for knowledge was linked to the future benefit and advantage of humankind as, for example, expressed in the preface to the first volume of the *Mitteilungen*: "A deep yearning and an inexorable striving for knowledge swells the breast," in the words of Petermann's editorial, as it seeks to uncover the "endless secrets of nature" with the goal of a "more profound understanding of our planet. […] The phenomena of the air, the rivers, the interior of the earth await investigation and a recognition of their fundamental laws: man needs to prophetically announce the hiding places of the golden metal which rules the world and to gird the world with the indispensable plants and animals" (Petermann 1855c: 1–2).

The map commentaries seem to testify to a recurring awareness for the finite availability and limited control of such resources and for the need to maintain them (Osterhammel 2009: 541–564). Conspicuous in this regard are the thoughts given to water. Such thoughts might be obvious when Europeans realize that plans to open up the African deserts for trade and development need to take the available water resources into account. The consideration of water supply occupies a prominent place in the commentaries to maps for virtually all regions of the world (for example, Petermann 1873a: 29–30; Stapff 1887; for the general importance of water see Blackbourn 2007; Radkau 2002: 108–109). The over-fishing of the seas also plays a role in connection with Antarctica. Petermann denounced the relentless hunting of whales and seals which had taken place in the early 1820s. Even his crown witness Weddell was actually travelling the high seas as a whaler. At the same time, Petermann invested his hopes in the export of guano from the southern polar regions with the justification that guano was a raw material which was naturally replenished. Admittedly, he did not realize that the production of guano occurred at a much slower rate than that at which it was depleted and that the import of guano would deeply impact the agricultural situation in Europe in the long term (Petermann 1863: 424–426; on the issue of guano, Radkau 2002: 223).

The exploitation of natural resources in the immediate European neighbouring countries was a topic of Petermann's *Mitteilungen* in 1883. In this year, the Perthes house published an up-to-date map of the areas exposed to the flooding of the Rhine which had been prompted by the high water mark reached by this river in the previous year. The map showed, as the commentary described it, "the old bed of the Rhine river next to the new one which had been realized as a result of regulation, dams and conduits. […] This regulation and the resulting curtailment of the river course was largely responsible for the catastrophe" (Rezension 1883: 67; Blackbourn 2007: 109). Human error and unchecked faith in progress had thus caused the disaster. It was only right that the proceeds from the sale of the map should benefit the victims of the flooding—even if no such act of charity could reverse the forceful impositions made by human society upon the course of the Rhine river.

5 Perspectives

Map commentaries document how authors and readers are embedded in the configuration of power relations and in the thought patterns of colonial and imperial realities and aspirations. They shed light on the projections of a society while at the same time drawing upon knowledge from the past and present. By turning the focus to some select examples, this article attempts a first approach towards a fuller exploration of the potential of map commentaries when they are treated as historical sources. The discussion revolved around the historical development as well as the form, function and content of these map commentaries. The diverse possibilities in analysing the commentaries could only be exemplified in a number of select cases. A systematic evaluation would have to include other geographical journals, broaden the time frame and provide a more detailed contextualisation of the map within the cartographical production process. It would be worthwhile to investigate more closely how and to what degree the ideas, notions and visions of cartographers and authors pre-determined the principles of selection in sifting at any given locality through the information which found its way into the map and the commentary. In addition to this, the textual and rhetorical structures of a map need to be compared to those of its commentary. A further task requires us to more precisely place the information presented in the map and commentary within the context and horizon of knowledge possessed by the cartographer and author.

The relationship between the repertoire of experience and the production of expectations within map commentaries is undoubtedly shot through with tensions. It would be worthwhile to subject it to more exacting analysis. This could yield further insights into the mental processes at the core of cartography.

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Abbrevation: PGM = Petermann's Geographische Mitteilungen

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Discovery of Forested Areas on Topographic Maps: Development of Orienteering Maps

László Zentai

Abstract Large-scale topographic maps were first created in the eighteenth century, but in the beginning their real use was limited to military people. Although forested areas were surveyed and shown on these maps, practically there was no military interest in forested areas. Cadastral mapping or engineering surveys focused on urban and rural areas only. In military training schools, cadets had to study field navigation including distance calculation and map-sketching, and cross-country activities became part of the military training. The civilian interest in sports, including cross-country races also became important at the time of Romanticism. This was an intellectual and artistic movement, which originated in the second half of the eighteenth century. It was also a reaction against the material changes in society, which accompanied the expanding industrial capitalism. According to the Romantics, the solution was to go "back to nature", because nature was seen as the source of renewal. At the end of the nineteenth century, all the prerequisites for orienteering as a sport (including unclassified topographic maps, at least in some Scandinavian countries and in Britain) were present. It was also the time when the first tourist maps were published; although most used only tracks and paths in the forested areas (originally these tracks and paths were created for forestry or hunting purposes). The development of orienteering maps clearly shows the process of the discovery of forested areas. This paper presents the major milestones of this development in the nineteenth, but mostly in the twentieth century.

1 Introduction

It is not easy to tell the first time in the history when forestry issues were regulated. It is known that the Visigothic Code (Lex Visigothorum, seventh century) defined the rules of forestry management and all kinds of activities in these

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areas, which showed the importance of forests in the contemporary economy (Scott 1982: 120).

Nevertheless, the practice of forestry and silviculture is little more than two hundred years old. It developed in Europe in response to an alarming shortage of wood caused by the conversion of forest to farmland and grazing land (there were also some smaller areas in Europe where forest areas were totally destroyed for building ships in the middle ages). Scientific forestry began in Germany in the 1780s. A short time later, the practice was also started in France and in other well-developed countries, where forestry was treated as an industrial instead of just a simple rural activity. Timber production became an important part of the modern economy, which required a more professional approach than previously (Robinson 1988: 10).

The age of modern silviculture started immediately after the beginning of regular topographic mapping. Scientific forestry could not work without very detailed maps; only topographic maps were good enough to support practical and scientific activities in forested areas. Topographic mapping was the privilege of the military forces, simply because only the leader of a country had enough power and resources to finance a countrywide survey. It was in the interest of the emperor to have a set of topographic maps in order to defend the country and use them for taxation and other governmental issues. For the topographic maps, all areas including forested ones were surveyed, but from a practical perspective there was no military interest in forested areas. Cadastral mapping or similar engineering surveys were focused only on urban and rural areas. Nevertheless, the military approach to representing forested areas on topographic maps was suitable for other, non-military users, but special forestry maps were also made (their geography was based on the official topographic maps).

2 Use of Topographic Maps

The map series Carte de Cassini was published in 1793. This was the first accurate topographic map of an entire country, France. This was the first topographic map series in the world that was capable to serve as an efficient tool of field navigation.

Maria Theresa, the ruler of the Habsburg dominions was not only the initiator of the First Military Survey (at a scale of 1:28 000) at the end of the 18th century, but she also issued a regulation on forestry. This regulation described the importance of surveying forested areas and establishing a link between surveying and the economic use of forests. The maps of this survey are not comparable to recent topographic maps: their precision and representation were based on contemporary mapping practices. Surveyors were concentrated on areas of human activities and there were many fewer details in forested areas than other areas. Except for few roads (which connected settlements) and the hachures depicting relief representation, the forested areas were left almost empty. Forested areas at that time were not even important for military purposes; these maps were hand-drawn and they were

Fig. 1 Map of the first military survey, 1:28 800, around the North Hungarian town Salgótarján, 1782 (courtesy of institute and museum of military history, Budapest)

copied only in case of war (Fig. 1). In addition, the emperor founded the Academy of Mining and Forestry, which is considered to have been the first technical university in the world. Forestry studies were also taught in this institute (Hurtt et al. 2006).

It was a very important period in the process of modernizing cartographic methods of relief representation, especially due to the invention of the contour lines method of relief depiction, which is common practice today. The only shortcoming of the early topographic maps was the general lack of elevation measurements, other than a few spot elevations determined by barometric heighting, if there were such measurements at all. Or the relief description was simply 'à la vue'. One of the first tourist maps was a map of the High Tatras made by a Swedish botanist, George Wahlenberg in the beginning of 19th century (Szaflarski 1959).

Although the use of contour lines allowed the accurate depiction of relief on a flat, two-dimensional map, they were not widely used until the mid-1800s, mostly due to the lack of efficient measuring techniques. Hachuring was an appropriate method of relief representation for military use because it showed the most relevant information, the slope angle, and the method was also expressive for less experienced map users. In general, contour lines were able to replace hachuring only after stereophotogrammetry was invented.

Although the Military Geographic Institute (Militärgeographische Institut) was only established in Austria-Hungary in 1839, military surveyors had already finished the First Military Survey by this time, and they were already working on the Second Military Survey. The governments of Europe reorganized their surveying institutions, and industrializing states committed significant resources to establish permanent mapping organizations in order to sustain increasingly intense territorial control. In most countries, these state maps were classified and were not available for civilian purposes. Several civilian activities (education, tourism, press) required suitable maps at that time, but the production of these maps was not normally based on military topographic maps. The available printing technologies also influenced the use of topographic maps; only the development of enhanced offset printing allowed the wide use of colour printed maps after 1910. Although at the end of nineteenth century several countries were creating their topographic map series using advanced field surveying methods, due to the printing facilities, these maps were printed in black and white (line engraving was an appropriate technique for printing hachures (Fig. 2).

According to the 1840 regulations of the Swedish Military Academy, cadets had to study field navigation because there were potential users of these topographic maps especially during wartime. These studies included distance calculation, map-sketching, and field navigation. Thus, cross-country activities became part of the military training. Since the beginning of the twentieth century navigational skills for military officers have become more and more important. The development of printing technologies made the colour printing of topographic maps more affordable, which allowed surveyors and cartographers to create topographic maps without the need to compromise.

3 Back to Nature, the Beginning of Modern Olympic Games

The civilian interest in sports, including cross-country races became important at the time of Romanticism. This was an intellectual and artistic movement, which originated in the second half of the eighteenth century. Romanticism was also a reaction against the material changes in society, which accompanied the expanding industrial capitalism. According to the Romantics, the solution was to go “back to nature”, as nature was seen as the source of renewal.

The traditional team sports are considered as originating from Europe, primarily England through the British Empire. This can be seen as discounting some of

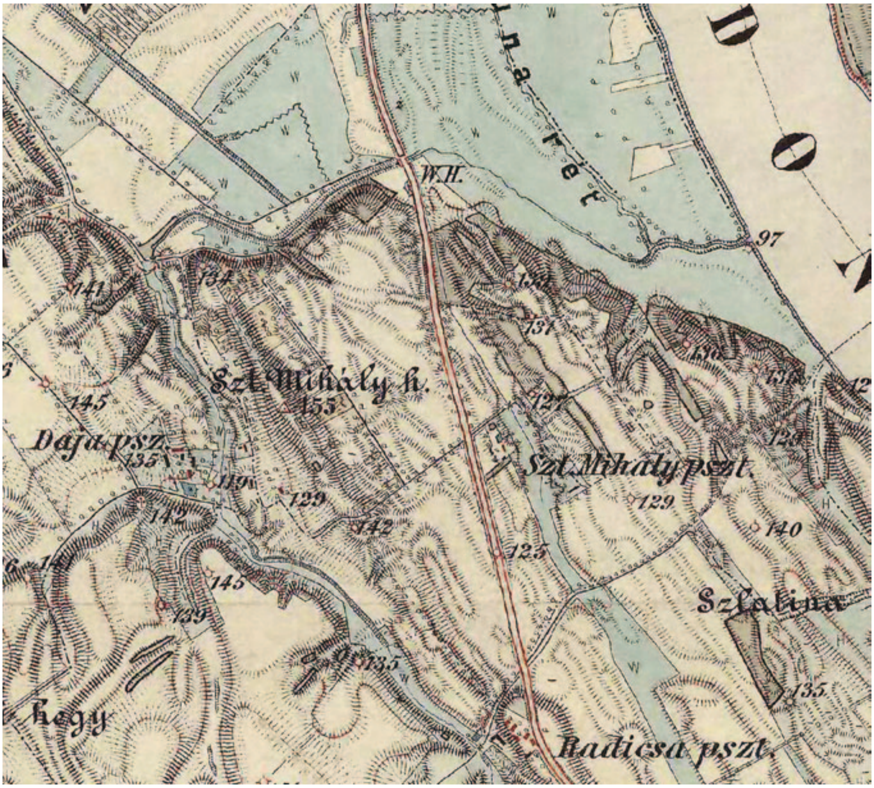

Fig. 2 Map of the third military survey, 1:25 000, North Hungary, 1883 (courtesy of Institute and Museum of Military History, Budapest)

the ancient games of cooperation from Asia and the Americas. Regardless of game origins, the Industrial Revolution and mass production brought increased leisure, which allowed more time to engage in playing or observing spectator sports, as well as less elitism in and greater accessibility to sports of many kinds. With the advent of mass media and global communication, professionalism became prevalent in sports, and this furthered sports popularity in general.

During the eighteenth century, several small-scale multi-sports festivals across Europe were organized (sometimes the term Olympian Games were used). In 1894, Pierre de Coubertin organized a congress in Paris to present his plans on the Olympic Games to the representatives of sports societies from different countries. Congress members suggested holding the inaugural modern Olympic Games in 1896. Athletics, cycling, fencing, gymnastics, shooting, swimming, tennis, weightlifting and wrestling were the sports of the first Olympic Games; rowing and yachting were also scheduled, but had to be cancelled due to poor weather on the planned day of competition.

4 Orienteering

At the end of the nineteenth century, all the requisites (including unclassified topographic maps, at least in some Scandinavian countries and in Britain) for orienteering as a sport were present. It was also the time when the first tourist maps were being published, although most tourists used only tracks and paths in the forested areas (originally these tracks and paths were probably created for forestry or hunting purposes).

In the mid-1890s, there was an increased interest in organized sports which was greatly encouraged by the example of the successful establishment of the modern Olympic Games. There was also an interest in lengthy races over unknown ground especially in Scandinavia. These races were sometimes called orienteering races. In 1890, Idrausforeningen (Sports Club) Tjalve was formed in Oslo as the first track and field club in Norway. Two years after its formation, the club organized a hare and hound race (this sport was also popular in the United Kingdom in early Victorian times), which was repeated in the following years. In 1897, the club wanted to try something new, namely an orienteering event. An explanation of the new form of event was not given except that the use of maps and compasses was allowed. Unfortunately, no record of the event has been kept to prove that maps were really used in this first event, but the position of the three control points is known. Nevertheless, it was probably impossible to finish the course in the time achieved by the best runners without using a map. There were four potential maps available for the runners to choose from.

- A topographic map at the scale 1:100 000 from 1872. This map was based on old measurements, which means that it was outdated.
- A topographic map from 1885 to 1887 based on measurements dating from 1880 with 10 m contour intervals and at 1:25 000 scale. Two adjacent maps were needed to cover the whole course.
- A skiing map at 1:30 000 with 20 m contour intervals (the most likely used map).
- A skiing map at 1:60 000 with 100 ft contour intervals from 1895. Although this was the newest map, it was based on a poor base map.

Getting to the first competition was a major undertaking with the communications and transport available at the time. Most participants probably bicycled, walked or ran the 20 km out to the starting place. The participants were given 30 min to study the course before they started. The organizers recommended that this time should be shortened at later races (Berglia et al. 1987; Myrvold 2005) (Fig. 3).

The first orienteering events in other Scandinavian countries were organized in

- 1899, Norway, ski orienteering (Norway was in union with Sweden and became independent in 1905 only)
- 1901, Sweden
- 1904, Finland (ski orienteering)
- 1906, Denmark

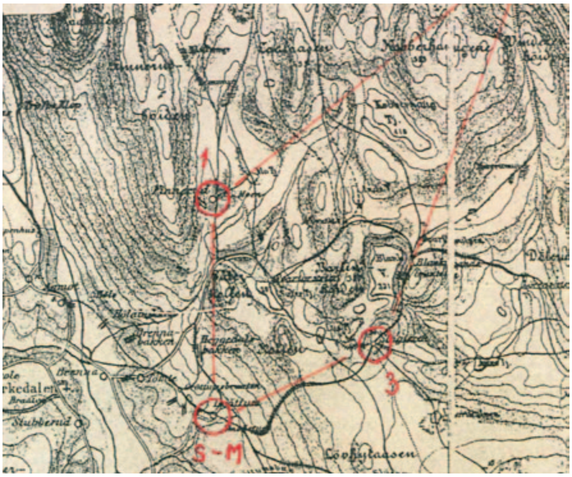

Fig. 3 One of the possible maps with the course of the first orienteering event, Norway, 1897 (courtesy of the Museum of Orienteering, Zlin, Czech Republic)

Other countries where the first orienteering event was organized between the two world wars, were

- 1925, Hungary
- 1926, Estonia
- 1933, Switzerland
- 1933, Czechoslovakia
- 1941, USA

The very first written rules were only suggestions, and were set by the Swedish clubs (most of these suggestions are still valid rules of the sport).

- The direction and length of the course is secret, the only public information is the venue of the race.
- The start should be individual.
- Five minutes before the first start, the competitors will be given a map with the first control station indicated. After arriving there, the controller will indicate the next control point and also stamp the control card of the competitor. The rules today are different; competitors get the whole course on the map when they start.
- The competitors shall run on foot without the help of other means of transport or communication.
- The course will be a minimum of 15, and a maximum of 25 km. Nowadays there are different courses depending on age classes and forms, and the courses are shorter with more control points.
- The competitor who finishes in the shortest time is the winner.

The Scandinavian clubs faced the problem that the topographic maps and tourist maps were simply not good enough for orienteering. It was a long process to reach the level of development where the sport was able to afford the new technical methods of surveying and printing. The development of orienteering also affected state cartography, at least in Scandinavian countries, where orienteering became one of the best-known sports. Today, most professional cartographers in these countries are fans of orienteering. Their request for more detailed maps in orienteering influenced the level of detail in state topographic maps.

4.1 Milestones of Orienteering Mapping

There is not much information available on the early years/decades of orienteering mapping. Orienteering was practised only in the Scandinavian countries before 1920 and few other countries (Hungary, Estonia, Switzerland, Czechoslovakia, USA) tried the sport before World War II. Although the first Hungarian orienteering event was organized in 1925 by a prisoner of war who came back to Hungary from the Soviet Union via Sweden, only few events were organized before World War II, and there was no impact on the development of the sport.

The rapid growth of the sport in Scandinavia was probably the result of a "back to nature" movement which swept across Europe in the 1920s. The "Wandervogel" movement was on the rise in Germany: boy scouts were increasing in numbers and youth hostels were spreading quickly. For nearly the first 30 years, orienteering had been only for men. The first event for women was held in Sweden in 1925. At the end of the twenties, about 5,000 people were considered active orienteers in Sweden. The sport grew so rapidly that it was considered a threat to some other established sports.

Between the two world wars, there were only minor developments in the maps used for orienteering. All Scandinavian countries made their first newly drawn maps, although these maps were based on existing topographic maps. Apparently, no new information was added to these maps. Nevertheless, the map was traced again especially for the orienteering event with the scale larger than the existing map.

The first orienteering map specifically drawn and field-worked for orienteering purposes was made in 1941 in Norway. This was an illegal night orienteering event during the German occupation, when the organizers had no alternative source of a suitable map for an orienteering event.

During World War II, the sales of maps were stopped in most Scandinavian countries, but after negotiations, reprints of maps for sanctioned orienteering events were allowed. Still the organizers were not allowed to make any corrections or additions to the existing maps.

Although Swedish orienteering was the strongest and the most developed before World War II, technical improvements in the sport were no longer a realm of the Swedes alone. The mapping revolution after World War II started in Norway shortly after the war and it was not until 1965 that Swedish orienteering realized what was going on. In 1948, Norway prepared the first orienteering map on which the contour lines were created from a special photogrammetric plot. This method was continuously used for the dissected Scandinavian terrains, but the spread of this method in orienteering maps was relatively slow in the beginning due to the high costs of stereophotogrammetry. Having developed the method to show more detail and represent more features on the orienteering map, the scale also had to increase to retain the legibility of the map. Using a larger scale also meant that the production of orienteering maps started to be independent of state topographic maps.

Another important development was the use of colour offset printing. After World War II, colour printing technology became more affordable. Due to the internationalization of orienteering, there was a demand to make orienteering maps more attractive. It must be remembered that the same development also occurred in the case of state topographic maps, which moved from black and white to colour when the technology became affordable. At that time, it was simply a financial question; advances in printing technology was not related to military activities, but rather to the press and media industry.

Offset printing (especially colour) was expensive and technically very difficult for the keen event organizers. To move a step further, the sport had to reach a higher level by increasing the number of participants in events, and by creating international connections and forming regional and continental organizations.

The very first colour offset orienteering map was created in 1950 for an international event, but for at least 10–15 years colour maps were rarely used (it was quite common to let the competitors colour their black and white maps with crayons before the start). This early period of orienteering maps was the age of home-made maps. In most countries (except Scandinavia), there were no suitable maps available for public use. Depending on the running speed and the course distance, the scale of maps was between 1:20 000 and 1:40 000 (between 1:50 000 and 1:100 000 in the early years). In some countries, topographic maps were classified (Eastern Europe), in other areas the largest available scale of topographic maps was only 1:50 000 (Germany, Spain). Using tourist maps was a logical alternative, but the accuracy of publicly available tourist maps was not suitable for the events in Eastern Europe. Therefore, in these countries organisers tried to find more accurate tourist maps which had been published before the communist era (Fig. 4).

At that time, there was no discussion about legends, specifications or standardization; in most countries it was a problem even for local participants to understand the maps as the symbols of orienteering maps changed from event to event.

As it was the time of the Cold War, sport was the scene of "battles" between the two main rival political systems. Although travelling abroad from Eastern European countries was very difficult or impossible, sportsmen were an exception. Scandinavian countries were much more open-minded or not so "Western" when looked at from the East, so sporting connections between the two regions started to develop.

There were mutual advantages:

- The Eastern European countries studied the developed level of orienteering (including maps) of Scandinavian countries.
- Organizing international events with more participating countries gave orienteering a better chance in each country to get more support from the state.

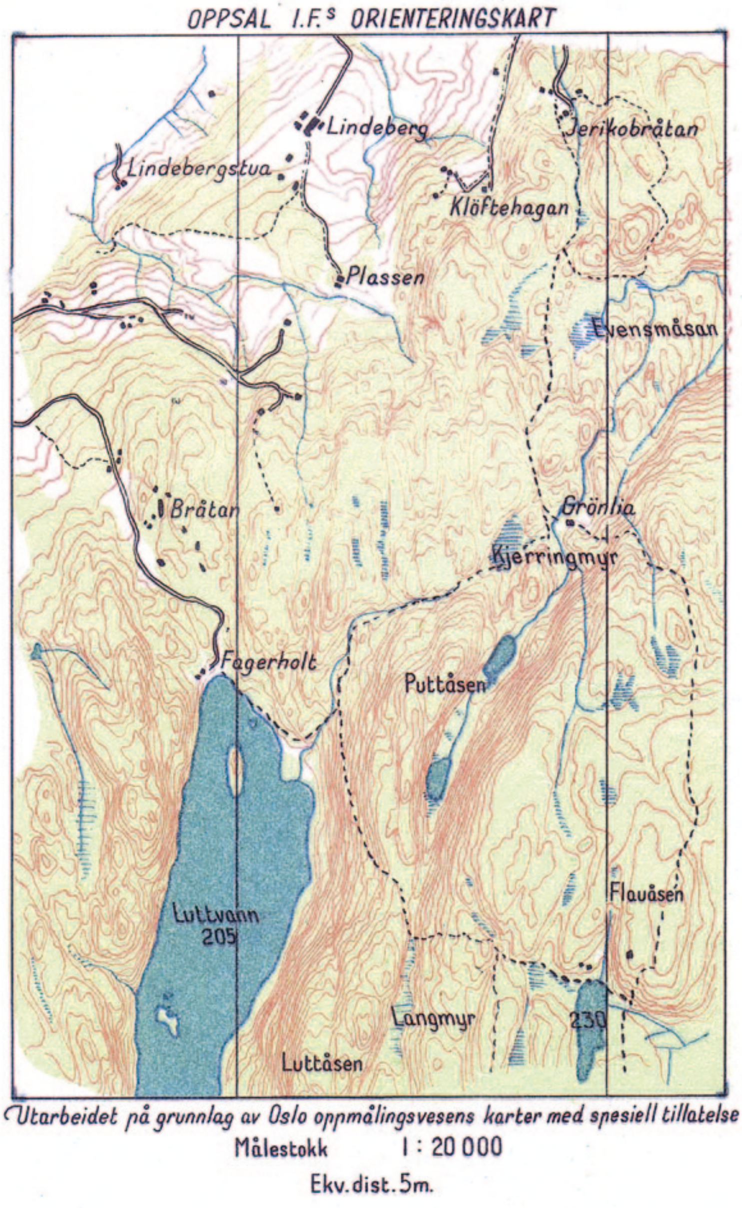

Fig. 4 The first colour offset orienteering map, Norway, 1950 (courtesy of Tor Valstad, Norway)

The real development of orienteering maps started with the "official" internationalization process. The International Orienteering Federation was founded in 1961 by five Eastern European and five West European countries (Bulgaria, Czechoslovakia, Denmark, Finland, Germany (East and West), Hungary, Norway, Sweden, and Switzerland). In 1962, the first European Championships was organized in Norway. The maps for the first international championships used the legend of the national topographic maps of the organizing country. This did not make the events all that fair, as interpretation of the map symbols was easier for the local participants (Fig. 5).

The International Orienteering Federation formed a Map Committee to establish a map standard. The process was relatively slow as the dominant orienteering countries all suggested their own map standards. All five members of the IOF Map Committee were cartographers (Jan Martin Larsen—Norway, Osmo Niemelä—Finland, Christer Palm—Sweden, Torkil Laursen—Denmark, Ernst Spiess—Switzerland).

At their first meeting in 1967 the Map Committee finally agreed on the following main principles:

- The orienteering maps must show the actual situation.
- They must show all visible features that are easily identifiable and useful for the competitors.
- It is very important to show all details that affect the route choice.
- The legibility is most important: all unnecessary features should be omitted.
- The maps of the international events have to use the same legend in all countries.

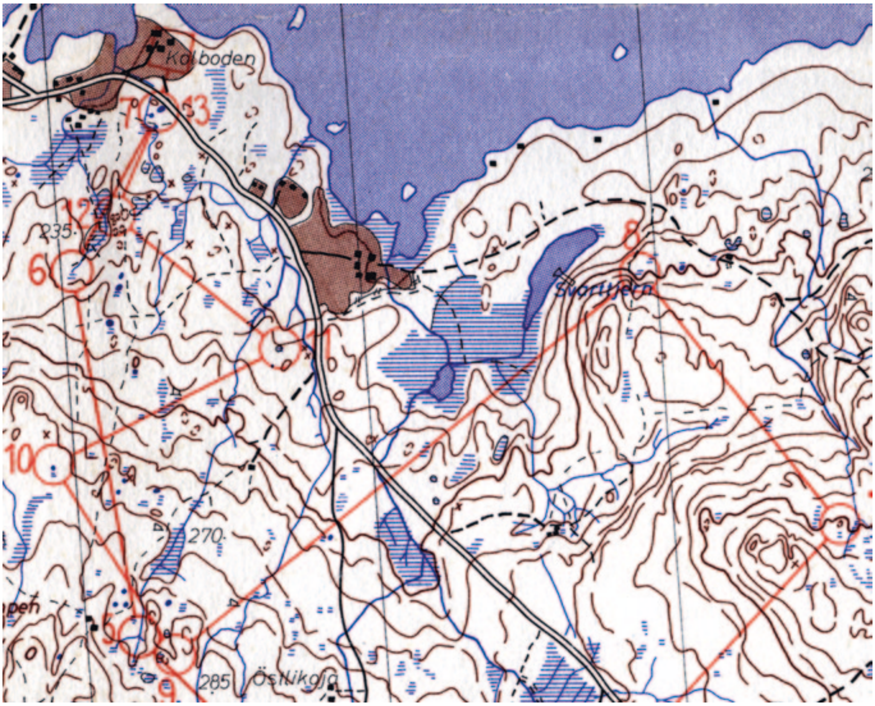

Fig. 5 Map of the first European championships (Norway, 1962) (courtesy of the International Orienteering Federation)

The first World Orienteering Championships was organized in 1966, replacing the former European Championships. Although there were only European members in the International Orienteering Federation, the ‘World’ title really speeded up the process of map standardization, which was one of the most important steps to make the orienteering a global sport.

The first non-European members of the IOF were Canada and Japan which joined in 1969. In 1973, when other important countries (USA, Australia and Israel) joined the IOF, the standardization of maps became a major issue.

The first international map specification was accepted in 1969, but this was only a short list of map symbols. From the middle of 1970s, the map standardization process speeded up (Spiess 1972). This was not only a period of standardizing the process, due to the demand for larger scales maps and the availability of modern technologies (special photogrammetric plots), the makers of orienteering maps also started to spend more and more time on field-work, and on creating maps of forested areas, which were more detailed than any previously published (Fig. 6).

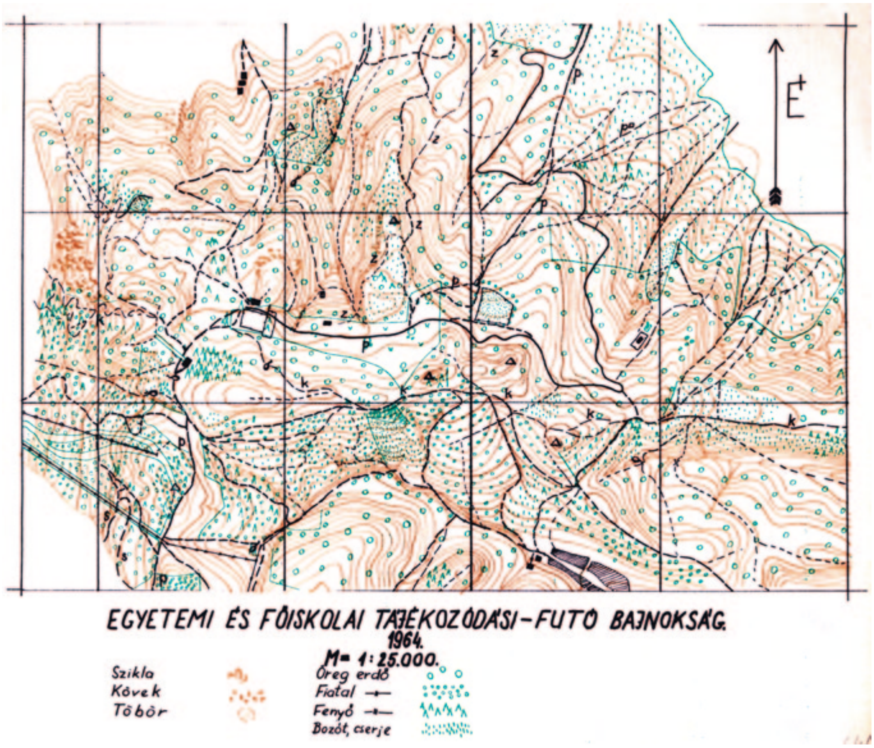

Fig. 6 The first colour offset printed orienteering map of Hungary field-worked for this purpose (1964). Both the drawing and the offset printing were made by amateurs without having permission for the process

One of the most intensive discussions in these years concerned the colour of the forests on the maps. In every country this area symbol was traditionally green on state topographic maps. It was originally a Norwegian suggestion in 1965 to use white (the paper colour itself) for forest. These maps were called negative maps, and after some years this suggestion was accepted internationally. The Scandinavian countries were also quite reluctant concerning the representation of the runability ("crossability") of forests. The Central European suggestion was to use different shades of green to represent the runability of forests, but as this was not a relevant factor in Scandinavian forests, these symbols were not widely used on Scandinavian terrains in the 1970s and 1980s. The globalization of the sport led to the solution of these problems: nowadays, the map specifications are accepted in every country using orienteering maps, making these maps one of the few map types where the map specification is standardized for every country (Zentai 2009).

5 Summary

The development of orienteering maps was a complex process, which was affected by various factors. It was mostly determined by financial and technical constrains, but political conditions were also a factor. Although the first civil event was organized in 1897, the development of orienteering maps during the first 40–50 years was very slow. The sport did not reach the level where the number of competitors would lead the organizers to develop a special type of map for orienteering. At that time, the sport used maps that were available and suitable for the competitions, such as topographic maps and tourist maps. After World War II, the situation changed, at least in Scandinavian countries. After rapid development in Scandinavia, the sport spread throughout Europe (in the 1960s and 1970s) and all over the world (in the 1980s and 1990s). After the discovery of forested areas, it was a time when, due to the demand for larger scale and more precise maps, the level of field-work exceeded the levels of any previous mapping of forested areas. The aim was to create maps that were suitable for the placement of control points on any part of the map. However, the main reason was to offer a fair tool to every participant to avoid the element of luck. Having more detail on the maps, especially in very complex areas, a new demand for increased legibility became more important.

Nowadays we have even better technologies, such as GPS and laser scanning, which offer an abundance of precise data. To produce a legible map requires good cartographic knowledge and orienteering skills. Today forests are no longer unknown areas, and there are no longer white spaces on the maps. However, representing these areas on orienteering maps is still a challenging task which provides a last chance for topographers to do a classical job of terrain mapping.

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Edward Sabine and the "Magnetic Crusade"

Peter Collier

Abstract The last decades of the nineteenth century witnessed a number of attempts at international cooperation in cartography, including the establishment of the Greenwich Meridian as the standard for both time and longitude, and Penck's proposal for the International Map of the World. What is less well known was an earlier cooperative venture, the so called 'Magnetic Crusade'. At a time when maritime navigation was still dependent on the magnetic compass, it was important to know the variations in magnetic declination. Edward Sabine was charged with running the Magnetic Department and established an international group of collaborators, including important scientists such as Gauss, to collect data from around the world. Sabine was also able to use the network of British colonies and their observatories and voyages of exploration to polar regions, including the Franklin relief missions, to collect data. This chapter will explore the work of Sabine's department, its network of collaborators, the attempts made to impose standards on the measurements made, and the maps it produced.

1 Introduction

There were a number of attempts at international cooperation in cartography in the last decades of the nineteenth century. The proposal to standardise time and longitude on Greenwich, replacing a multitude of local times and local meridians, is perhaps the best known. Penck's proposal for an International Map of the World, with standardised scale and symbolisation was never fully realised. However, these were not the earliest examples of international cooperation. In the middle of the nineteenth century a now, largely forgotten, international campaign was successfully pursued to measure and map variations in terrestrial magnetism. Edward Sabine, the mastermind of this campaign, was in his day a famous man of science, but like his campaign he is now largely forgotten. While the scientific and political aspects of

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this work have been discussed in a number of papers (see for example O'Hara 1983; and Cawood 1979), little has been written about the more cartographic aspects of the work, or about it as an international enterprise.

The magnetic compass was a fundamental tool in European maritime navigation from the around the end of the twelfth century until the development of gyro compasses, although the Chinese had been using them from sometime between the ninth and eleventh centuries (Temple 2007: 162–166). Problems with compasses due to the attraction of magnetic objects on ships became apparent with some of the early trans Atlantic voyages of the early sixteenth century, but the problem of variations in magnetic declination only started to become apparent with voyages into polar or near polar regions. Stephen Burrowes is usually credited with first noting the problem on a voyage off North Cape. Gellibrand, a professor at Gresham College, determined the amount of the variation and in 1635 published a paper on the subject (van Bemmeln 1898). Edmond Halley made a number of voyages in the late seventeenth and early eighteenth centuries which were sponsored by the English government to chart magnetic variations, publishing his results in the Philosophical Transactions of the Royal Society, together with his theory for the variations in intensity and direction (Fig. 1).

In the early nineteenth century, the work of Alexander von Humboldt, Jean-Baptiste Biot and François Arago, amongst others, reawakened British interest in the field of terrestrial magnetism at a time considerable scientific rivalry between Britain and France. As Cawood (1979) demonstrates, the revival of interest in terrestrial magnetism was also bound up with the development of the British Association for the Advancement of Science and the politics of early nineteenth century science. As Cawood (1979) notes, the leading men of science involved, John Herschel, William Whewell, George Peacock, and Humphrey Lloyd, were all associated with the reform movement within British science. The campaign to study terrestrial magnetism became, in the words of one of those involved 'by far the greatest scientific undertaking the world has ever seen' (Whewell 1857).

The scheme was not originally a British conception. The originator was Alexander von Humboldt, who had already established a number of magnetic observatories in Russia. In 1836 Humboldt had written to the President of the Royal Society to advocate the establishment of a series of observatories in British territories in which simultaneous observations could be made. Airy and Christie were asked by the Council of the Royal Society to report on Humboldt's letter. In their report they drew attention to the advantages of participating in such a scheme and identified the best locations for the proposed observatories (Christie and Airy 1837). They also noted that Humboldt urged direct cooperation between the Royal Society of London, the Royal Society of Göttingen, the Royal Institute of France and the Imperial Academy of Russia. The letter from Humboldt gave great encouragement to the British advocates of the programme in presenting a case to the government.

As the crusade was not a solely British affair, the role of Edward Sabine in managing an array of international collaborators, and Humphrey Lloyd in developing the necessary scientific apparatus, were to be key to its successful prosecution. In practice, Sabine was never able to convince Arago to cooperate, and cooperation with Göttingen was partial, at best.

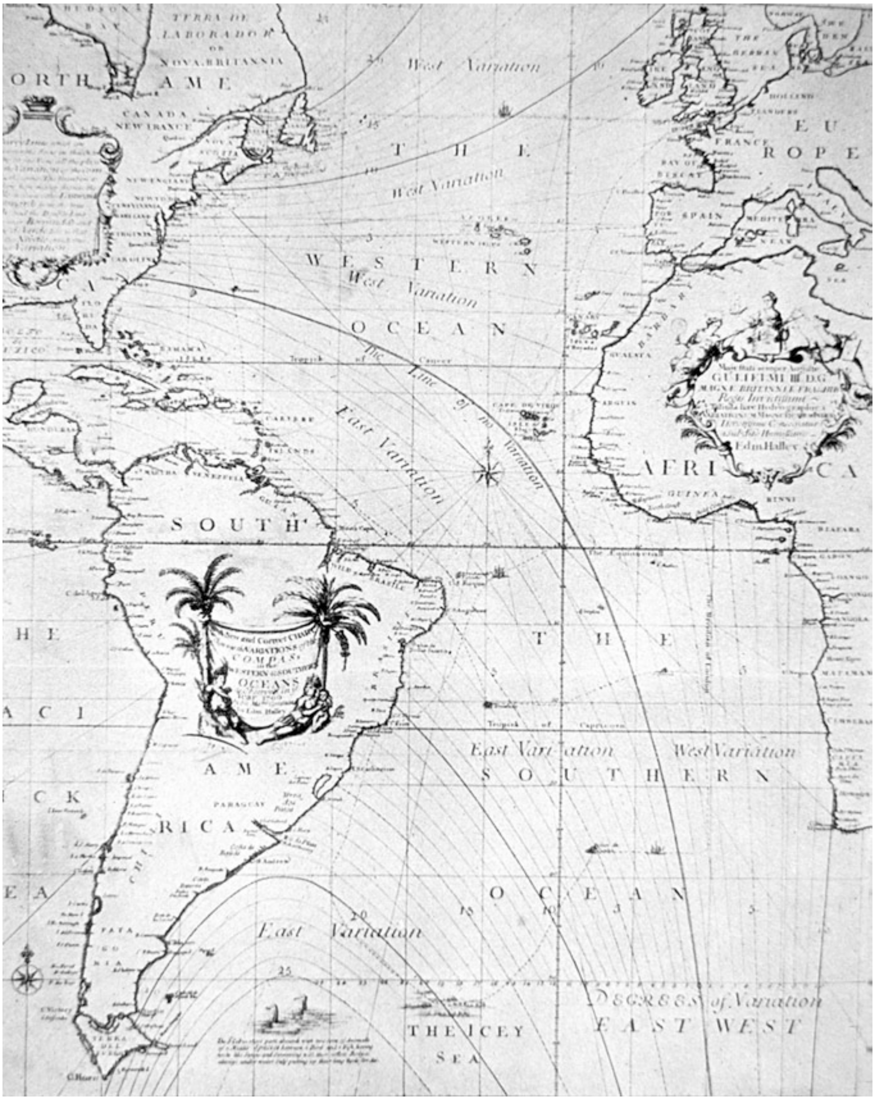

Fig. 1 Halley map of magnetic declination (courtesy of NOAA)

2 Edward Sabine

Edward Sabine is little remembered today, but in the mid nineteenth century, he was amongst the most famous men of science in Britain. Sabine was born into an Anglo-Irish military family in Dublin in 1788. At fourteen he entered the Royal Military Academy at Woolwich and was commissioned into the Royal Artillery in December 1803, at the age of just fifteen. After service in Gibraltar and various home stations, he was sent to Canada in 1813, serving during the defence of Quebec and in the Niagara Campaign against the Americans. Although Sabine was to retire with the rank of General, he never again saw active service, nor saw much regular military service during the rest of his career. Following the end of the North American and Napoleonic Wars, Sabine became interested in scientific matters, and these became the focus of the rest of his life.

Through his family connections he found it easy to enter into the scientific life of early nineteenth century Britain. His eldest brother, Joseph, was a founder member of the Linnean Society, and his brother-in-law, Henry Browne, provided Sabine with his first magnetic instruments and tuition. In 1818 he was assigned as astronomer to John Ross's polar expedition (Fleming 1998: 38). Among his tasks were the measurement of the direction and intensity of the earth's magnetic field, determination of longitude and latitude, observations of atmospheric refraction and the aurorae. His work on the Ross expedition led to his first paper on magnetic variations (Sabine 1819), although the voyage also led to a quarrel between Sabine and Ross over Sabine's assignments and the credit for the work he had carried out. The quarrel with Ross had no adverse affect on Sabine's career and in 1819, he sailed again, this time with William Edward Parry (Fleming 1998: 63), on the first British expedition that overwintered in the Arctic. James Clark Ross also worked with Sabine on the Parry expedition, and was to work with Sabine again on the magnetic survey of Ireland in the 1830s.

In the 1820s Sabine was chiefly involved in geodetic research, measuring variations in gravity in the Atlantic, Caribbean and Spitzbergen. In 1825 he worked with Herschel and two French scientists on the determination of the longitude differences between the London and Paris meridians. This was followed in 1827 and 1829 with a comparative study of gravity pendulums and magnetometers at the Paris and Altona observatories. This work carried out with François Arago and Heinrich Schumacher brought him into contact with other prominent scientists.

In 1834 Sabine worked with James Clark Ross and Humphrey Lloyd on the magnetic survey of Ireland. Lloyd, who was astronomer at the Dublin Observatory, was to be one of Sabine's most important collaborators on the Magnetic Crusade, and largely responsible for the design of the equipment used (O'Hara 1983). He subsequently carried out magnetic surveys in Scotland (1835) and in England (1836). During this time he was actively building support for the "magnetic crusade", which he was to run through the Magnetic Department, until it closed in 1877.

3 Building Support for the Magnetic Crusade

An important connection for Sabine's future career and the magnetic crusade that was made through his polar work was with John Barrow, Secretary to the Admiralty. Barrow, through his work in the Admiralty, actively promoted exploration, and polar exploration in particular. The Barrow connection was to benefit him enormously as through it he gained access to naval facilities, normally unavailable to Army officers. Barrow also supported the election of Sabine to the Royal Society. Another of Sabine’s naval supporters was Francis Beaufort, Hydrographer to the Admiralty, an important voice in both scientific and naval circles.

Sabine was also busy building a network within scientific circles, initially at the Royal Society. As Good (2011) notes, Sabine was very good at working within societies and institutions, using his connections to further his scientific work. He became a secretary of the Royal Society in the 1820s, and in 1828 a member of the board of scientific advisors (a body that had replace the Board of Longitude). As Good (2011) also notes, Sabine was not a reformer, while most of the scientist with whom he was to collaborate on the magnetic crusade were very much opposed to the nepotism which was a feature of the early nineteenth century Royal Society. However, Sabine’s personal qualities and organisational ability meant that he did not alienate these important allies. Sabine was slow to recognise the potential importance of the British Association for the Advancement of Science (founded 1831), joining only in 1835. However, once he had joined he used the annual meetings to present the results of his work and to promote his activities. In 1839 he became its General Secretary, and President in 1859. In 1845 he was appointed Foreign Secretary of the Royal Society, in 1850 he was elected Treasurer and Vice-President, and President from 1861 to 1871. It is worth noting that in his work as Foreign Secretary of the Royal Society, and in his other dealings with foreign scientists, he was greatly assisted by his wife, Elizabeth, a linguist who translated works by von Humboldt, Arago and von Wrangel.

In addition to support from the Admiralty, Royal Society and British Association, Sabine was also able to draw on the support from the Army. He had been granted relief from normal duties to pursue his scientific career by the Duke of Wellington, and apart from a period in Ireland in the 1830s he was free to continue with that career. His plans for a network of magnetic observatories would need the services of Army officers to carry out the observations. While the support of the Admiralty for the crusade made practical sense, there was no obvious benefit to the Army. However, in the post-Napoleonic period there were few opportunities for employment and advancement for Army officers, and many officers would have welcomed the break from normal duties and the possibility it offered of advancement. The Army was therefore happy to second officers to the crusade, usually from the Royal Artillery, although it often raised problems regarding the costs incurred. Sabine started building his support for the crusade in 1835, and with support from Parliament, the campaign obtained the support of the Melbourne government in 1839 for James Clark Ross’s Antarctic expedition.

4 The Aims of the Magnetic Crusade

As Good (2011) notes, the magnetic crusade had a number of aims. The first aim was to acquire masses of data. This would involve the use of ships and a network of magnetic observatories collecting data over many years. A second aim was to understand the cause of geomagnetism and the laws governing it. A third aim was to put together the necessary instruments, facilities and personnel to carry out the crusade, on a scale never before attempted for any scientific endeavour. Sabine's earlier work with Ross and Lloyd in Ireland had done much to lay the ground work for the project, and both Ross and Lloyd were to play a significant role in its work. Sabine had also encouraged amateur men of science to collect magnetic data during their travels. For example in 1838 Mr Ainsworth carried out a series of observations of magnetic intensity while on a journey to Constantinople. Once he had arrived in Constantinople, Ainsworth was able to send to Sabine the needles used in making the observations, using a warship and via Francis Beaufort. The needles themselves had been previously used on Chesney's Euphrates expedition. Before Ainsworth journey the needles had also been compared with others due to be used on an expedition to Kurdistan. It is clear that the crusade was in some senses just bringing together and systematising something which was already happening.

In Europe, François Arago, Carl Friedrich Gauss and Christopher Hansteen had done much to advance the theory of geomagnetism, and the work of the crusade was very much informed by their theories. However, it was far from being one-way traffic. While Sabine had the first English account of Hansteen's theory, Gauss's own work drew on the data presented by Sabine in the 1836 Report of the British Association. Ainsworth had also used Arago's cabinet at the Paris Observatory when making his observations there. In addition to the magnetic observatories already established at European astronomical observatories, Alexander von Humboldt had also established a number of magnetic observatories in Russia, which were subsequently taken over by Gauss. Part of the aim of the magnetic crusade was to use, and even extend, the continental network of observatories, through negotiation with scientist like Gauss and Arago.

5 Operationalising the Crusade: The Imperial Network

As noted above, the crusade as originally envisaged, involved the use of British warships to collect magnetic data on voyages across the oceans and in polar regions. In addition, magnetic observatories were to be established, usually in association with existing astronomical observatories. Special care had to be taken in constructing the magnetic observatories, which had to be of wood, with only copper nails being used in the construction.

Humphrey Lloyd had already established a magnetic observatory in Dublin, but under the planned crusade, there was to be a magnetic observatory in Greenwich, together with four manned by members of the Royal Artillery in Toronto, Cape of Good Hope, Van Dieman's Land and on St Helena, and four supported by the East India Company in Madras, Simla, Bombay and Singapore.

Prior to being sent to set up the observatories, the personnel selected were usually sent to Dublin to receive instruction from Humphrey Lloyd on carrying out the observations. They were then supplied with a set of equipment. Lieutenant Lefroy, who was to be an important contributor to the crusade, and an important scientist in his own right, before going in October 1842 to carry out observations in Upper Canada, was supplied with the following equipment:

1. An inclinometer of nine French inches diameter, by Gambey (this instrument was being lent by Robert Fitzroy, and had previously been lent for the magnetic survey of the British Isles, demonstrating the key role still being played in scientific research by wealthy amateurs).
2. A Fox's inclinometer of seven inches diameter.
3. A portable unifilar magnetometer for the measurement of absolute horizontal force.
4. An azimuth compass.
5. A portable declinometer.
6. A portable bifilar magnetometer.
7. A portable induction inclinometer (Sabine 1846: 240).

Sabine provided very detailed instructions regarding how the observations were to be conducted. This was reinforced from time to time by circulars sent to the various observatories (see, for example Sabine 1841).

Lefroy had previously been sent in 1839 to establish the observatory on St Helena. Conditions must have been fairly primitive and the allowances paid inadequate, despite the government funding, as in 1842 Lefroy was forced to write to Sabine requesting the money to buy forage for his horse, a request that Sabine had to forward to the Deputy Adjutant General's Office for approval by the Lords of the Treasury (Magnetic Department Letter Book 1842).

Lefroy had been sent to Canada to become Superintendent of the Toronto Observatory. As part of his work there he carried out an eighteen month expedition, travelling some 5,000 miles and with his assistant, Bombardier Henry, carried out observations at more than 300 stations. However, Lefroy was unusual in carrying out observations over such a wide area, most observations were made at or near the established observatories.

Among the naval expeditions that carried out magnetic observations was that of James Clark Ross. Ross left England in late 1839 and headed south with two ships, HMS Erebus and HMS Terror, stopping at St Helena to establish the observatory used by Lefroy. They then stopped at the Cape to establish the observatory there. In May they reached Kerguelen Island, where they established a temporary observatory and recorded hourly readings for two months. They then sailed for Hobart, arriving in mid August and constructing the third observatory of the voyage.

On 12 November Ross's ships headed south, crossing the Antarctic Circle on 1 January 1841, After breaking through an outer barrier of pack ice, the two ships proceeded south discovering two volcanoes (Erebus and Terror) and the ice shelf which bears Ross's name, all the time conducting magnetic measurements. After exploring along the ice shelf for 250 miles, Ross finally turned back to over-winter in Hobart (Sabine 1843a). The first season of exploration and measurements were followed by a second season between July 1841 and April 1842, when they arrived at the Falkland Islands (Sabine 1844). In 1845, the Pagoda, under Lieutenant TEL Moore of the Royal Navy was sent from Cape Town to complete the survey of high southern latitudes (Sabine 1846).

6 Operationalising the Crusade: The International Network

While Sabine had more or less direct control over the observatories within the Empire, he had far less control over those of the international participants, and some, such as Arago in Paris refused all cooperation. More interesting was the relationship with the Magnetische Verein centred on Göttingen and on the work of Gauss and Weber. While the whole network used Göttingen Mean Time as the basis for observations, the Verein did not participate fully as it employed its own system of observations (Cawood 1979: 513).

In 1839 Sabine and Lloyd travelled to Göttingen, Berlin and St Petersburg to complete the arrangements for the planned observations. Following the trip, Lloyd was able to report to Herschel that the Russian observatories were prepared to cooperate and that Adolf Theodor Kupffer of St Petersburg had agreed to reorganise the observatories at St Petersburg and Barnaoul to correspond with British observatories, he held out little hope of cooperation with Göttingen, Berlin or Leipzig (Lloyd 1839). He was also able to report that Adolphe Quetelet in Brussels, Carl August von Steinheil in Munich, Palm Heinrich Ludwig von Boguslavsky in Breslau, Karl Kreil in Prague, and his successor in Milan, had agreed to participate.

In 1842 Lloyd reported that ten Russian observatories had participated, St Petersburg, Yekaterinburg and Kazan in European Russia, Helsingfors in Finland, Nikolayev in the Crimea, Tiflis in Georgia, Barnaul and Nerchinsk in Siberia, Sitka in North America and Beijing in China. In addition, observatories in Algiers, Brussels, Prague, Milan, Breslau, Munich, Cadiz, Philadelphia, Cambridge (Masachussets), Cairo, Trevandrum and Lucknow had carried out observations. The observatories in Algiers, Brussels, Breslau, Cadiz, Cambridge, Cairo, Trevandrum and Lucknow had all used instruments of similar design to those in Dublin. It is interesting to note that the observatories in Trevandrum and Lucknow were founded by the local rulers, the Rajah of Travancore and the King of Oude, respectively, and were in addition to those established by the East India Company.

While Lloyd could only encourage foreign observatories to use the same or similar designs for the equipment to those that he was using in Dublin, Sabine could insist that any expeditions supported by the British Government had to use equipment approved by Lloyd and himself. Although Gauss and Weber resisted any changes to their working methods and equipment, most of the measurements were made with compatible equipment, ensuring a high degree of standardisation. It is also worth noting that, despite the disagreements over the conduct of observations, Gauss and Sabine remained on good terms.

An important factor that helped Sabine to maintain his network, and his key place within it, was that his correspondents anywhere in the world could send him data without having to pay for its transmission. As he wrote to John Locke in Cincinnati, if the packet addressed to Sabine was enclosed within an outer envelope addressed to Secretary of the Admiralty, London, and put into the post office in Boston or New York, it would be sent to him free of postage (Sabine 1843b). As John Barrow was still then Secretary of the Admiralty, this was clearly a continuing benefit resulting from Barrow's patronage.

7 Cartographic Output of the Magnetic Crusade

As noted above, the main aims of the crusade involved the collection of vast amounts of data and the development of improved theories. There were, however, more practical products of the work in the form of maps showing variations in magnetic force and magnetic declination around the world. The first of these (Fig. 2) accompanied "Contributions to Terrestrial Magnetism" (Sabine 1840). Which was the first of ten papers published in the *Philosophical Transactions of the Royal Society* between 1840 and 1866, not all of which contained maps. The map was derived from observations collected by a Lieut. Sulivan RN during voyages to and from the Falkland Islands in 1838 and 1839, and a series of observations made between 1834 and 1839 by James Dunlap of the Paramatta Observatory.

The next map to appear accompanied "Contributions to Terrestrial Magnetism No. III" (Sabine 1842). The map depicts the course and magnetic force reading captured by Sabine's friend James Clarke Ross during the 1840 voyage in HMS Erebus. Apart from the locations of a few points for reference, such as Trinidad and Ascension Island, no geographical features are shown Fig. 3.

"Contributions No. IV" (Sabine 1843a) mainly contained data but no map. "Contributions No. V" (Sabine 1843c) continues on from No. III, and covers Ross's voyage with the HMS Erebus and HMS Terror, between November 1840 and April 1841. This contribution is accompanied by three maps, one showing variations in magnetic intensity, and one show variations in magnetic inclination, and one showing magnetic declination. All three maps show some coastline. "Contributions No.VI" (Sabine 1844) depicts the courses and observations of both HMS Erebus and HMS Terror between May 1841 and August 1842. Unlike the earlier maps, this shows much more detail of coastline.

While the earlier "Contributions" were all a product of naval voyages more or less under Sabine's control, "Contributions VII" is the first fruit of Sabine's international network. Subtitled "Containing a Magnetic Survey of a considerable portion of the North American Continent", it drew mainly on the observations of Lefroy and Henry, but also drew on observations made by "several gentlemen of the United States" (Sabine 1846). Sabine's American collaborators included Major James D. Graham, United States Corps of Topographical Engineers, who was a

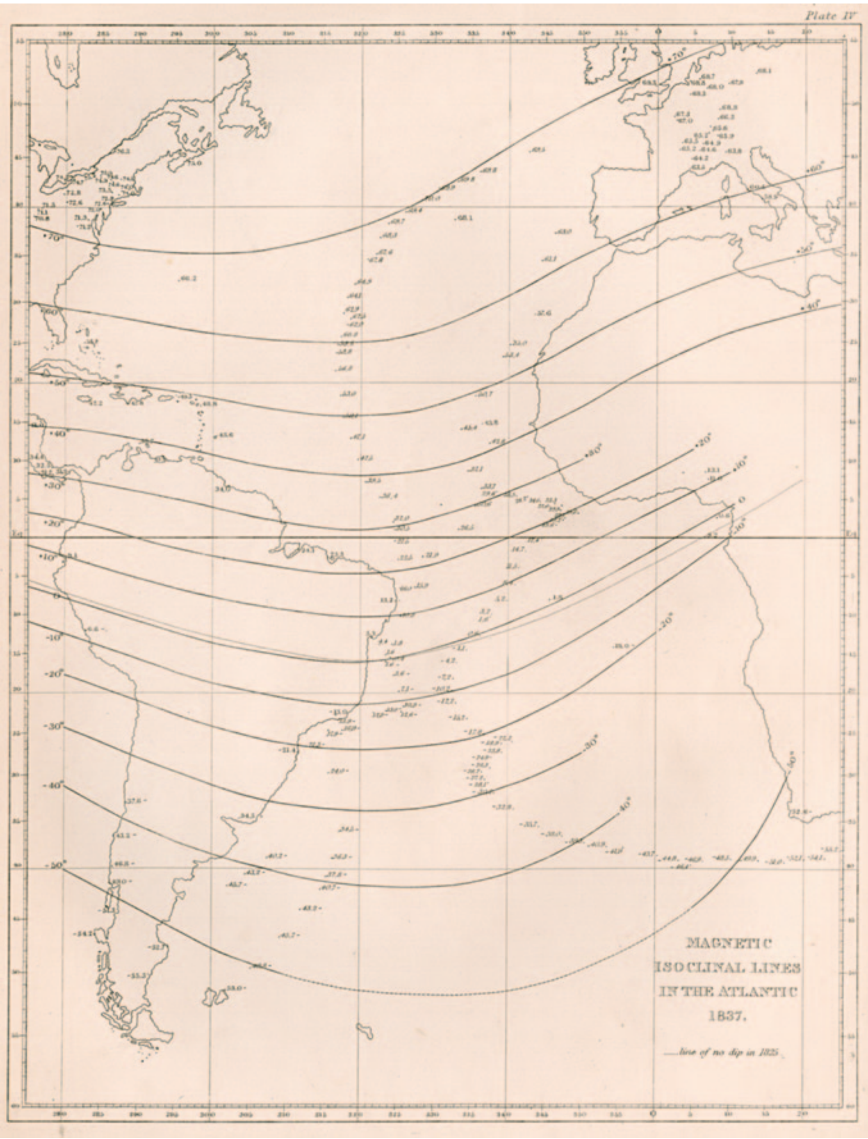

Fig. 2 Map to accompany “contributions to terrestrial magnetism” (Sabine 1840 © Royal Society)

Commissioner, Principal Astronomer and Head of the Scientific Corps engaged in the boundary demarcation between the United States and British North America. Graham’s observations were mainly obtained in the course of the boundary survey between 1841 and 1845. Dr Locke of Cincinnati provided data on 100 stations between the eastern seaboard and the Mississippi and between 38° and 48° North.

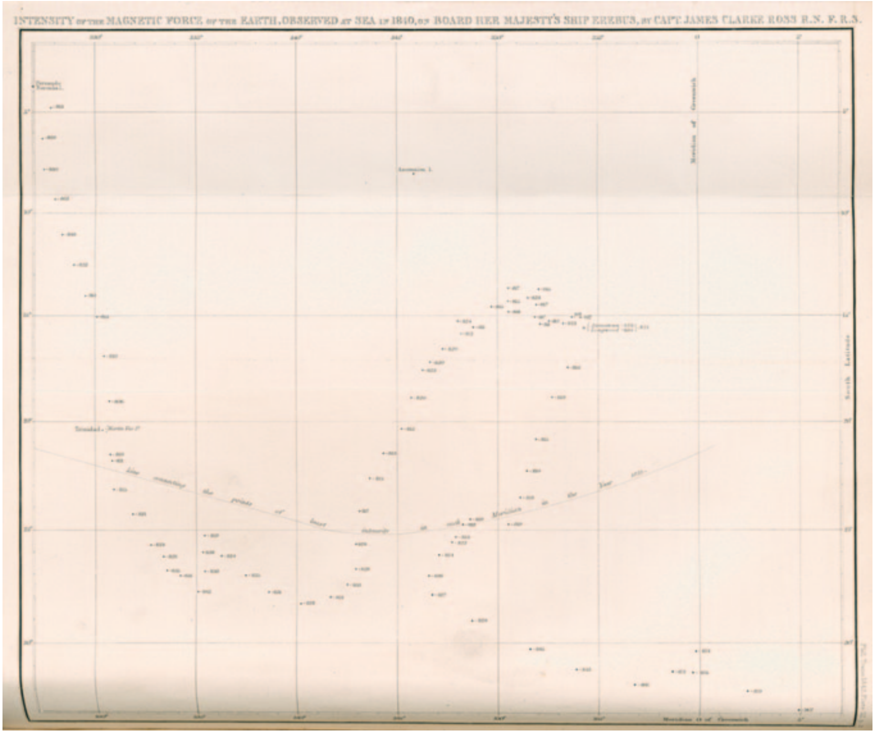

Fig. 3 Map to accompany "contributions to terrestrial magnetism no. III" (Sabine 1842) showing Ross's course in his voyage during 1840 on HMS Erebus (© Royal Society)

Dr Alexander Dallas Bache, Director of the Coast Survey of the United States and James Renwick provided data collected as part of their work for the United States Government, and Sabine also drew on published observations carried out by Loomis and Nicollet. From the data Sabine was able to produce two maps, of isoclinal lines and isodynamic lines (Fig. 4).

Contributions to Terrestrial Magnetism IX (Sabine 1849) contained maps of the Atlantic Ocean between 60° North and 60° South (Fig. 5). The map of declination was produced after "repeated representations from the Hydrographer of the Admiralty", who urgently required such a map for the purposes of navigation. The map was produced using 1,480 individual determinations made between 1828 and 1840, all reduced to 1840 by taking into account annual rates of change. To do this Sabine had taken the map produced in 1787 by Hansteen to calculate average rates of change for each location used. The data came from 15 voyages and 15 series of land based series of observations, including those made by Robert Fitzroy in 1832–1834 on the coast of South America and on the Falkland Islands while on the Beagle. Observations were also taken from observatories at Algiers, Brussels, the Cape of Good Hope, Christiania, Dublin, Greenwich, Makerstoun, Paris, St Helena and Toronto.

Fig. 4 Map to accompany "contributions to terrestrial magnetism no. VII" (Sabine 1846) showing magnetic inclination over North America (© Royal Society)

Although there were further "Contributions" published over the next couple of decades, some of which had maps, while others consisted mainly of tables, Sabine was drawn more and more into investigations of data from a few permanent observatories, primarily Kew. It was from the runs of data recorded at these stations that Sabine was able to develop his ideas concerning the influence of the moon on variations in geomagnetism.

All the major reports on the Magnetic Crusade and its cartographic products were produced by Sabine. Indeed, Sabine oversaw all the computations carried out on the raw data supplied by the various observatories and expeditions. This was a source of friction with some of the observers who wished to carry out their own computations. In this context, it is interesting to note that Lefroy did not publish an account of his expedition until the year of Sabine's death (Lefroy 1883).

As can be seen from the examples included, the maps were very simple in their design. In common with most maps of the time they were monochrome, and hand colouring was a luxury rarely lavished on maps published in journals. The maps are all at small scale, although no indication is give of scale on the maps themselves. Considering the maps were intended to form a series illustrating the data captured during the magnetic crusade, there was no attempt to provide standardisation of lettering. Given the areal coverage of the sheets, it is not surprising that a variety of projections were employed, although none are identified on the maps. From the maps examined, the Mercator projection seems to have been used for the Atlantic maps, but a conic projection was used for the Southern Ocean and North

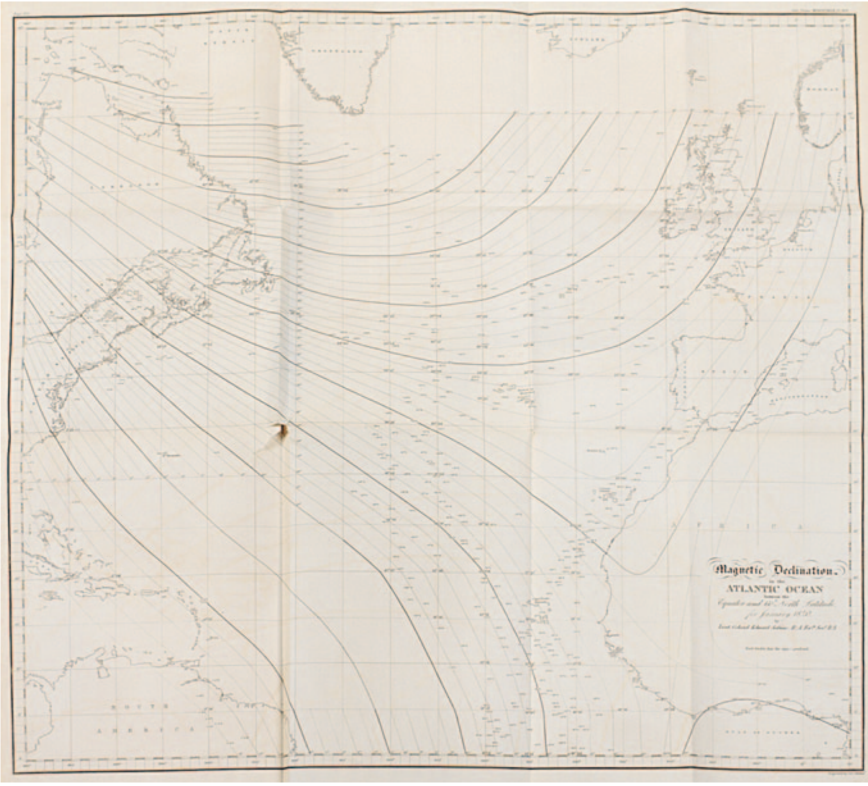

Fig. 5 Map of the Atlantic between 0° and 60° north to accompany “contributions to terrestrial magnetism no. IX” (Sabine 1849) showing magnetic declination (© Royal Society)

America. The use of the Mercator projection made sense for the Atlantic maps, since they were intended to provide data for navigation charts, but the choice of conics for the other maps requires further exploration.

8 Conclusions

The magnetic crusade was a pioneering example of international cooperation in data collection for scientific purposes. The data collected served both the scientific understanding of both temporal and spatial variations in terrestrial magnetism, and improvements in navigation at a time when the magnetic compass was still an important instrument. Sabine’s role was important in creating the organisational infrastructure necessary to maintain the campaign involving so many people and over such a time span. Lloyd’s role was important in defining standardised equipment and a standardised mode of observation. The reluctance of Gauss and Weber to participate in no way detracted from the final work. Importantly, through publication in the Philosophical Transactions of the raw data, the formulae used in the calculations and the calculated results, Sabine provided all the information needed to check his results, and if necessary change the results by applying different formulae. The publication of all the data also meant that anyone wishing to create larger scale charts could do so from the published data, which normally had geographical coordinates to 1 min of arc. The scale of the project and the vast amount of data it generated lend support to Whewell's (1857) contention that it was the greatest scientific project of its, or any previous age.

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Author Biography

Peter Collier was formally employed as a cartographer and photogrammetrist at the Directorate of Overseas Surveys before following an academic career. He always had an interest in the history of survey and mapping, and this has been mainly focused on the development and application of new technologies. Since 2001 he has been involved in the History of Cartography project, initially as an author of an exploratory essay, and subsequently as the author of several entries for Volume 6 (20th century). More recently he has also worked as an Associate Editor on Volume 6. He is also on the advisory Board for Volume 5. He has been a vice chair of the Commission on the History of Cartography of the ICA since 2007, organising a symposium for the commission in Portsmouth in 2008. In 2011 Peter took over as editor of the journal *Survey Review*.

Name Location on Old Maps

Ferjan J. Ormeling

Abstract When studying old maps as sources for toponyms, one finds that in the past habits of locating names on maps prevailed that are different from the present. These different habits have a direct bearing on the result of toponymical map studies: there are many areas in the world where neighbouring states use conflicting names for the same geographical objects, and are supporting their name claims with old maps. Examples are the collections of old maps recently published by either Japan or the Republic of Korea on the East Sea/Sea of Japan. In order to gauge the relevance of old maps in place name conflicts, this paper analyses

- the influence of the map function on the location of names (charts e.g. tend to keep the sea area as much free of names as possible)
- the influence of the relation of the mapped area to the map frame (a wide map frame necessitates the inclusion of other names than a more narrowly fitting frame)
- the contemporary meaning of names belonging to a specific object category (the name 'Sea of Japan' could mean the sea to navigate through in order to reach Japan, the sea in which Japan was located or the specific geographical sea area named after Japan)
- the relation between the name and the named object (which can have the shape of a point, line or area)
- the relation between the name and other names (there may be a hierarchy of names, like continent-country-province) which has a bearing on the named object.

Without insight in these name locating habits and their bearing on the resulting maps, toponymical map use results will lose their relevance.

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1 Mistakes in Reading Names from Old Maps

Early maps are interpreted in many ways, one of which is establishing (former) relationships between named geographical objects and their names. Such an analysis might show how an object was named in the past by cartographers, and in such a way we might be able to establish a name history. For those not versed in the interpretation of early maps, there are some pitfalls, however:

1. the procedure of splitting up names often is counterproductive to legibility
2. the named object and its name might not be adjacent
3. named objects might have been interpreted differently in the past as compared to the present.

After studying current cartographic practice in applying names to the map, 16–18th century practices will be investigated and as an example of changing interpretation of map object categories, seas are dealt with.

2 Current Naming Procedures

When applying names to maps, one should differentiate between the names of point-, linear and area objects. For the latter, it is current procedure to characterize the extent of the areas to be named by their names, at least in one direction, if the objects are large enough to contain their names (see Fig. 1a). If they are not large enough, the name will be placed so close to the object that everyone will automatically assume that there is an unequivocal link between object and name (see Fig. 1b).

Similarly, for linear objects like rivers we tend to let their names run parallel to them, preferably so that the names seem to rest on the objects.

For point objects, a hierarchical system has been worked out, as to which location of the name label in relation to the named object is optimal, for perceiving the link between object and object label best. A position above and to the right of the named point object has the highest priority (1), Positions on the same line as the named object, to its right or to its left, are worst (see Fig. 2).

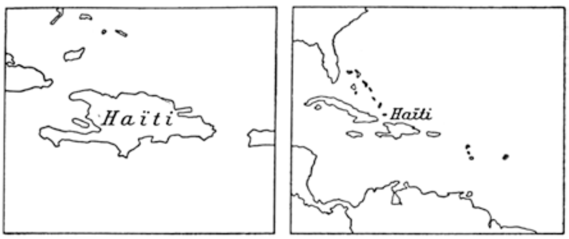

Fig. 1 Areal names, on larger and smaller scales (Imhof 1962)

Fig. 2 Hierarchy of optimal label positions for a point object, from 1 (best) to 8 (worst)

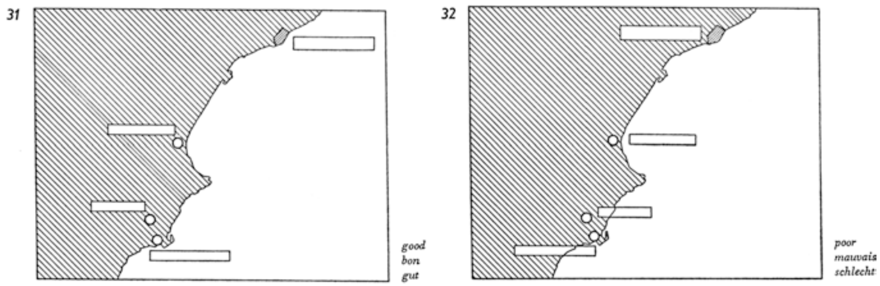

Fig. 3 At *right* bad solution; at *left* good solution for locating names for objects on or near the coast (Imhof 1962)

Sometimes additional rules are needed when a dominant line element, such as a state boundary or a river, dissects the name pattern, or when there is an interface between land and sea. Imhof gives the following rules (1962):

1. For places to the left of a river, if possible the whole name should be rendered to its left. Places located to its right should have their name to the right of the river as well. Places on the river, like Budapest should have their name bridge the river.
2. For aesthetical reasons, names should be rendered on land, and not in the sea area, and certainly not amphibiously half on land and half on sea. Against this aesthetical requirement, on behalf of good legibility, names of coastal places should be rendered completely in the sea area; places close to the sea but without an actual coastal location should have their names completely on land (see Fig. 3).
3. On small scale maps with a high names density, legibility requires the names of all coastal places to be positioned in the sea.

In *Elements of Cartography* (1995), Robinson gives a good idea of the application of these rules, especially for area names. He shows that, if letters are spaced out, the same optical distance between the individual letters should be adhered to, so that one can expect where to find the next letter. This clearly is a nineteenth century innovation, a rule which was not adhered to before.

Generally, we try to speed up map reading by promoting the expectation level of names by distinguishing different map object category names by different lettering styles: if we know that we are looking for the name of a big city or of a sea strait, we can find in the legend that e.g. for the first black roman capitals are used, and for the second blue italic lower case letters, and that will make it easier to locate these names on the map.

We have not only learned, as cartographers, to letter maps according to these rules, but as map users we have also accustomed ourselves to interpret maps by them. A widely spaced area name refers to an extensive area, and a closely serrated name belongs to a small area. Names on land refer to land objects, names on sea refer to sea objects or to coastal objects, etc.

This is all very well, if only we do not transfer this modern map reading practice to maps lettered in the past, and by doing so draw the wrong conclusions from them. It will be shown that either different lettering rules or no rules at all were followed in early cartography, and that different notions reigned regarding the nature of some object categories, which make it questionable to interpret old maps as if they were current ones.

3 Past Lettering Practices

Except for typographical innovators like Mercator and Waghenaer, cartographers in the sixteenth and seventeenth century had scant regard for the legibility of map type for area names. On most chorographic maps it looks like area names have been inserted after all other names had already been engraved, and that usually necessitated splitting up of these areal names. This in turn in many cases led to almost illegible areal names, or real puzzle pictures. See e.g. Fig. 4.

In many maps there was—apart from larger type or upper case areal names—no distinguishing of object categories by means of type variations: all object categories were indicated with the same script type. Figure 5 is an example. Here, Vingboons presents 19 toponyms, written parallel to each other starting from the coast on the mainland, on the Tsiompa (Champa, present South Vietnam) coast. Of these 19 names (see Box 1), four refer to islands on the coast (preceded by I for island or P

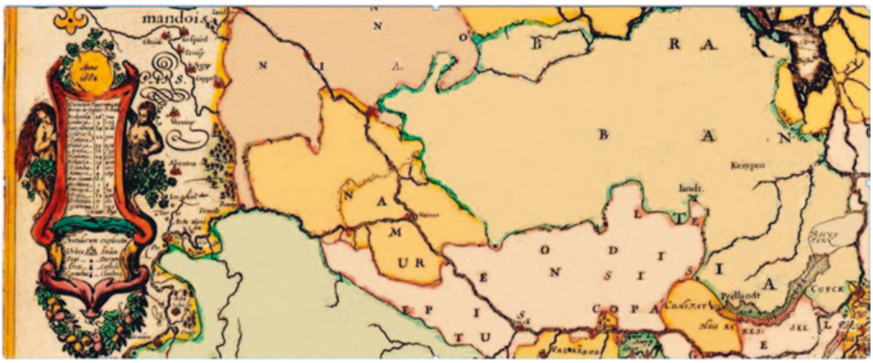

Fig. 4 Frederik de Wit's map of the Netherlands (Nova XVII Provinciarum Inferioris Germaniae Descriptio, 1662) with all names suppressed except for the areal names: find the names BRA-BAN-T-I-A (duchy of Brabant) and L-E-ODI-ENSI-S-EP-IS-COPA-TU (bishopric of Liège) intertwined

Fig. 5 Detail from a manuscript map of Asia by Johannes Vingboons, 1665, Atlas Blaeu-Van der Hem, 39:02, Österreichische Nationalbibliothek. See Box 1 for interpretation of the names

Box 1 Names in coastal position from south to north, in the map on Fig. 5

Name on the Vingboons map	Present Name
oude tomaõ bonasa	–
P.duartais (island)	–
P. Çeçir de terra (island)	Cu Lao Hon
Pta. de Paderaõ/C. Çeçir(cape)	Pointe Lagan
Avarella falça (cape)	Mui Da Vaich
Aru. mallebaij (bay)	–
C. de Joaõ fiz (bay)	Baie de Vang Fong
P. cambir de terra (island)	Cu Lao Xanh
Chemchu (city)	Qui Nhon
R.Cotang = R.Cantaon (river)	Song Tra Khuc-
Boxhoornen (mountain)	–
R.Ongong or Zongong (river)	–
P.Catno or P. Catao (island)	Cu Lao Re-
C.Bantang = Kaap Batang (cape)	Cap Batangan
Tactcham	–
Camelec	–
Caijhan	–
Senhoo	–

for poulo or pulau, Malay for island), two refer to rivers (preceded by R), four to capes (preceded by C), and two to bays (one preceded by b) so it is these prefixes that one has to take account of, especially as many specifics occur, both as island, cape and bay. There is no differentiation of type, but there is a differentiation in colour (on the original map, names on the land are rendered in black, names on the sea in red). Examples like these, lead to the comment that in the sixteenth and seventeenth century, there generally was not the same care in relating named objects or object categories to their names as is the case nowadays.

4 Influence of Map Functions

Lettering practice also was function-dependent: for sixteenth and seventeenth century charts it was current practice to have as few names in the sea area as possible, in order to keep it free for navigational annotations.

The effects are that names of islands close to the mainland coast are rendered on the mainland coast, opposite the location of each specific island (see the example of Hainan in Fig. 7). This may also have contributed to the hesitation to incorporate sea names to charts: sea names are introduced much earlier to atlas maps than to charts. The only maritime names incorporated to charts well up to the 19th century are the names of sea straits.

The habit of placing the names of islands off the coast on the mainland coast is also shown in Figs. 6 and 7. In Fig. 6 the name of the island Cambir de terre (Po.Cambir de Terra) is inscribed on the mainland opposite the position of the island and in Fig. 7 all the islands off the coast of Hainan island have their names inserted on Hainan opposite their position on the coast.

5 Changing Concepts

To date, lettering maps in the sixteenth and seventeenth century has shown up a bit like a misdirection game. But even if there seems to be a clear visual connection between names and named objects, this connection might take different meanings from the present. As an example the case of sea names in East-Asia is used.

Fig. 6 From an anonymous VOC manuscript map of the Gulf of Siam 1661 (Paris, Bibliothèque Institut de France Ms 1288). After Schilder and Kok, *Sailing for the East* 2010 (the map is oriented towards the south). Here the name of the island Po.Cambir de Terra (Gambir of Cu Laso Xanh, 13-37 N/109-21E) on the coast of South Vietnam is rendered rather laboriously. There is no room to locate it at sea because of the name of the fictitious island Cambir de Ma(a)r. Other names on the mainland are B.Cambier (Baie de Cu Mong), Schuijts Baij (12-52N109/25E) and Cabo De Avarellas (Mui Nay, 12-54 N/109-28E). This map is oriented towards the south

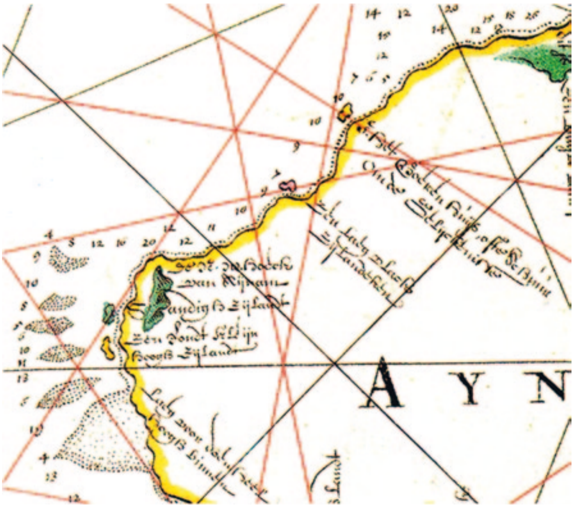

Fig. 7 Names on the northwest coast of Hainan island: From left to right: *Een rondt kleijn hoogh Eijlandt, Sandigh Eijlandt, de N.W.hoeck van Hijnam, Een laeg vlack Eijlandeken* and *I. het Boerenhuijs ofte Schuur, om de gelijckenisse*. In translation: "A round small high island, Sandy Island, the NW Cape of Hainan, a low flat small island and the Farm or Shed island, named after its likeness". So the names of the four islands off the west coast of Hainan have been inserted on Hainan itself. *Source* manuscript map of the Gulf of Tonkin (Boght Toncqin by Joan Blaeu 1663. Maritiem Museum Rotterdam K 4072)

Just as this has been the case with mountains, seas have been individualised over time. From general impediments they have been turned into individual resources. At least in Europe, names of individual mountain ranges have not been coined and applied to maps before the second half of the eighteenth century. Seas have been dealt with in a similar way, about 50 years later. It is only after 1800 that individually named seas are demarcated and their names entered in maps. Possibly because they became the object of scientific research or because they were influenced by the ordering spirit of Encyclopaedists or by the educational practice of grouping elementary objects into larger collections (Ormeling 2010).

In the Netherlands, the road from Utrecht to Amsterdam for travellers from Utrecht is named the *Amsterdam road*, about halfway it will change its name into *Utrecht road*, as this would be the road those from Amsterdam would have to take to get to Utrecht. Similarly the sea to navigate through from Japan to Korea becomes the Korean sea; the same sea for those travelling from Korea to Japan would become the Japan Sea. This **directional sea naming** concept differs from the present one, in which precisely demarcated seas have fixed names, the latter practice is referred to here as the territorial sea concept.

Another maritime concept is that of coastal waters in an extended sense. According to that notion, the Sea of Java is the sea in which Java is located, or the sea that waters the Javanese shores. Thus, on seventeenth century maps by Adrian Reland we see the name *Zee van Iava* or *De Iavaansche Zee* on both sides of the isle of Java. That would imply that Java is located in or that its coastlines are swept by, the Javanese sea.

By the end of the nineteenth century, the name *Timor Sea* (Timorzee in Dutch) still referred to the sea on both sides of Timor (see for example *Dornseifens atlas van Oost- en West-Indië* (1901), until this name was standardised in the next century as referring to the sea between Timor, Tanimbar and Australia, the other half of the previous Timor sea being named *Savu Sea* (*or Sawoe Zee in Dutch*), which is attested for the first time in 1921. In 1900 the *Sawoe Zee* was still experienced as a variant name for the Timorzee. The Dutch name *Timorzee* is attested first in 1844, its English version in 1833 (Breton). The sea boundaries between the various seas discerned were finally demarcated and fixed in 1953 by the International Hydrographic Organization through its special publication *Limits of Oceans and Seas*.

To what extent names on maps may be misinterpreted, can be seen from the following map pair from the *Arcano del mare*, a guide for navigators produced by Robert Dudley in 1646. In its first edition a map of Japan is included (see Fig. 8) which contains the name *Oceano Boreale del Giappone* (North Ocean of Japan); it looks like irrefutable evidence of the fact that the sea area bounded by Japan and Korea was called after Japan as early as 1646, which seems an early example of the **territorial sea concept**. It is also the first map to mention the *Mare de Corai*. But if we look at the revised map Dudley produced for the next edition, published in 1647, (Fig. 9) then instead of the *Oceano Boreale de Giappone*, there is not only a *Mare Boreale del Giappone*, but simultaneously there are three more 'seas of Japan', on all sides of the island, thus negating the concept of the territorial sea, between fixed positions and promoting instead the notion that the Sea of Japan was the sea in which Japan was located (thus sea in the sense of **coastal waters**). The **directional sea concept** alluded to before is also supported by this 1647 map: the South sea of Hokkaido (*Il Mare Australe di Iezo e tempestoso;* at that time the island of Iezo or Hokkaido was not integrated yet in Japan) meets with the North Sea of Japan (*Il Mare Settentrionale di Giappone*) in the same way as was alluded to in the example of the road between Utrecht and Amsterdam (Ormeling 2012).

As also has been the case for the Persian Gulf, the number of times a specific body of water on atlas maps contained a specific name instead of other names, has been used as evidence that such a name was in dominant use at a specific time. The example from Dudley has shown that—as the notions what a sea name referred to changed over time, and as the territorial interpretation of sea names was only introduced at about 1800, counting the number of atlas editions published before 1800 and containing a specific name version, makes little sense, as sea names before 1800 were interpreted in a different sense as compared to now.

What has not been covered as yet is that the sea names inserted by Europeans on maps of Asia had little connexion with the sea names used by the Asians themselves. In Korea in order to refer to the sea east of their peninsula people used the name *Dong He* or East Sea for 2000 years, before being forced to use the name Sea of Japan during the Japanese colonization from 1905–1945. All the sea names imposed by western nations on the seas in between the Malay and Philippine archipelagos had no local reference either.

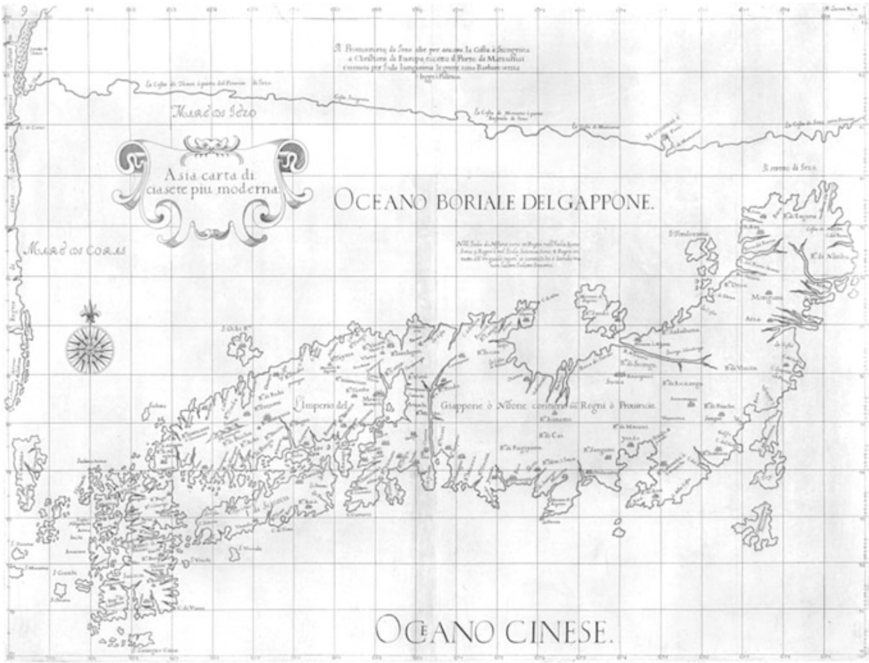

Fig. 8 Robert Dudley map of Japan from the *Arcano del Mare* edition 1646

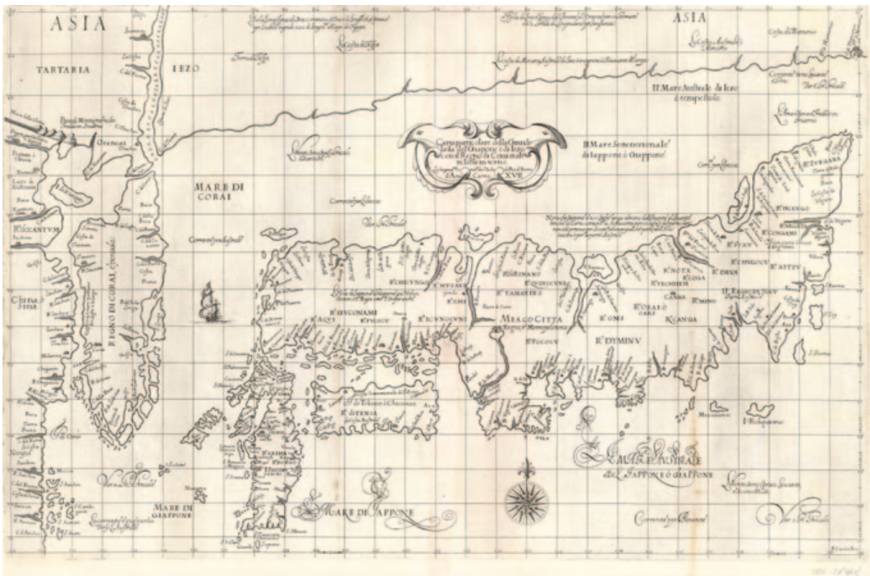

Fig. 9 Robert Dudley map of Japan from the *Arcano del Mare* edition 1647

6 Map Frames and Name Hierarchies

The influence of the map frame on the names contained in the map is still to be considered, especially for island realms. This is because the demarcation of the map frame would determine where large sea areas would result on the map that -so to speak- were waiting to be named. Cartographers used to be subject to a horror vacui, a fear for empty regions, and consequently would try to fill in such empty spaces with names. In that sense, a comparison between the sea names on maps of Japan and on smaller scale maps of Asia or of East Asia would show that different sea names are inserted for the same sea area.

Within a larger frame where the name Eastern Ocean, Oceano Oriental, Mar Pacifico or its equivalents would be inserted, there would be less need for incorporating the name *Sea of Japan* to the southeast of that realm. Of course, the smaller the map scale, the less room there would be for names, and consequently a selection would have to be made, leaving only the names of the most important geographical objects within the map frame, and omitting the names of objects with a lower hierarchical order.

That idea of the hierarchy is strengthened by Vincenzo Coronelli who in his atlas *Corso geografico universale* (1692) in the map of Japan (see Fig. 10) placed the name *Oceano Oriental* at both sides of Japan, and had *Mare del Giapone* and

Fig. 10 Map of Japan by Vicenzo Coronelli, 1692

Mare della China clearly as subsets of this ocean. I interpret this as that the Mare del Giapone was the sea that watered the Japanese shores and the Mare della China (apparently Korea was seen as part) as the seas that watered China's coast, but that both were part of the Oceano Oriental, that would be the only sea name to retain on the smallest map scales.

7 Concluding Remarks

Both in the Republic of Korea[1] and in Japan[2] inventories were published recently of printed maps showing Korea and Japan and the sea in-between, with sea-names in sympathy with the relevant position of the respective nations. The underlying principle was, that the case for the selection of a specific name would be strengthened if it could be proved that that name had already been used predominantly in different periods in the past. The number of cases in which a specific name version was found on different maps or in different atlas editions was used as argument to prove a case.

In such toponymical analyses of historical maps, only the fact that a specific name was printed in a specific sea area was registered (the name location), and the names were not put into context with other names on the map (name hierarchy), nor were different views on the meaning of sea names (directional names, coastal waters, etc.) taken into account. More important still is the fact that the occurrence of specific name versions on specific maps as such does not prove which name versions were predominantly used at a specific time. If maps were to be the only source to derive the dominant name versions from, then their circulation numbers or print runs would have to be taken into account as well. Other important sources to be used in order to assess the predominant geographical names currently in use, would be travel books, guides for mariners and encyclopaedias. These sources could only provide a correct picture when used in conjunction with another, and then this picture then would still only be valid for the European countries from which these sources derived.

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Author Biography

Ferjan Ormeling did a PhD on the rendering of minority names on topographic maps of Western Europe. He has represented the Netherlands in the United Nations Group of Experts since 1980, currently as vice-chair, and is convenor of the UNGEGN Working Group on Training Courses in Toponymy. In the latter capacity he organizes toponymy training courses world-wide. For the ICA Commission on Education and Training, which he chaired from 1987–1999, he designed a webcourse on toponymy.

From 1991–1999 he organized, at the ICHC conferences, meetings between historians of cartography and those teaching cartography, publishing the results in the series *Teaching the History of Cartography*. Since 2000 he has been a member of the Utrecht University Explokart research group in the history of Cartography and is serving as one of the editors of its monograph series *Utrecht Studies in Map History*. In 2005 he published a monograph on the history of the Bosatlas, the major school atlas in the Netherlands, which has been published since 1877 and now is in its 54th edition. His main interest in the history of cartography is the colonial cartography of the Netherlands East and West Indies.

From 1985–2010 he held the chair of cartography at Utrecht University; from 1999–2007 he was Secretary-General of the ICA.