

MAPPING 'MACEDONIA'S FIVE MOST EXCELLENT CITIES' - WHAT DO BYZANTINE STUDIES, AUSTRIAN CARTOGRAPHY FROM THE 1830S AND GIS HAVE IN COMMON?

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1. BACKGROUND AND OBJECTIVES

Since 1966 research on the historical geography of South-East Europe during Byzantine rule, i.e. in the period between 330 AD and 1453 AD, has been successfully conducted by the Institute for Byzantine Studies of the Austrian Academy of Sciences (Vienna) within the project *Tabula Imperii Byzantini* (hereafter *TIB*). The main objective of the *TIB* is to create an atlas of the Byzantine Empire by publishing volumes on each of its provinces.

The main part of every volume of the *TIB* comprises a catalogue of the original Byzantine names of towns, settlements, fortresses, churches, monasteries, fields, mountains, rivers and lakes in alphabetical order, which is extracted for each province of the Byzantine Empire from four categories of sources: written sources from the above-mentioned period (e.g. historiography, inscriptions etc.), archaeological evidence (monuments and their remnants), toponyms and the physical state of landscapes.

The collected and sorted information is presented in headwords (i.e. lemmata). Each headword contains the (approximate) localisation (if possible) of a place found in the sources and data on its history and monuments. The sources used and the most important bibliography are quoted at the end of a lemma. There the reader also finds information as to whether surveys were conducted in situ by the scholars of the *TIB*. These have the aim to localise visible monuments and to document their current state by means of digital photography.

Furthermore, each volume of the *TIB* contains introductory chapters on the geography, climate, history, administration, church history, population, lines of communication and the economy of the studied province of the Byzantine Empire as well as a register.

The results of each volume are presented to the reader on a map on the scale of 1 : 800,000 with the headwords marked onto it. Special symbols and combinations of colours indicate the nature of the monument and its dating. The maps also include historical places for whose existence there is only archaeological evidence without knowledge of their ancient (Byzantine) names.

Eleven volumes of the main series of the *TIB* have been edited since 1966, whereas one volume is in press [written by Klaus-Peter Todt and Bernd Andreas Vest on 'Syria' (*TIB* 15)] and six volumes are in preparation at the moment. Peter Soustal is doing research on 'Macedonia, Southern Part' (*TIB* 11), Klaus Belke on 'Bithynia and Hellespont' (*TIB* 13), Friedrich Hild on 'Caria' (*TIB* 14), , Mihailo Popovic on 'Macedonia, Northern Part' (*TIB* 16) and Andreas Külzer on 'Lydia' (*TIB* 17) and 'Asia' (*TIB* 18) (cf. **fig. 1**).



The overall picture of the project is enriched by the fact that a series entitled *Veröffentlichungen der Kommission für die Tabula Imperii Byzantini (VTIB)* has been edited since the 1970s in addition to the main series of the *TIB*. This has made possible the publication of detailed studies on the historical geography of Byzantium and of congress proceedings, which could not be presented in the main series due to lack of space. A complete list of the above-mentioned publications can be accessed via

<http://www.oeaw.ac.at/byzanz/vtib.htm> and <http://www.oeaw.ac.at/byzanz/vbf.htm> (viewed 19 January 2011). [1]

The authors of the present paper are working together on the historical region of Macedonia (i.e. *TIB* 11 and *TIB* 16). Mihailo Popovic in particular is enriching the methods applied within the *TIB* by using advanced techniques such as GPS, GIS and Historic Landscape Characterisation during his surveys. He is currently undertaking research on the basis of the FWF – Austrian Science Fund stand-alone project entitled ‘Economy and Regional Trade Routes in Northern Macedonia (12th-16th Century)’ (project P 21137-G19) under the supervision of Prof. Dr. Johannes Koder, the head of the *TIB*, in order to test the applicability and the usefulness of the above-mentioned techniques for the overall project of the *TIB*. [2]

Mihailo Popovic has united the results of this project in a professorial dissertation (Habilitationsschrift) entitled ‘Von den Quellen zum Visuellen in der historischen Geographie. Zentrale Orte, Siedlungstheorien und Geoinformatik, angewendet auf die historische Landschaft Makedonien (13. bis 16. Jahrhundert)’. Furthermore, a case study on the function of ‘least-cost path’ calculations within the project *TIB* will be published soon by him and his co-author Julison J. Jubanski. [3]

One of the main obstacles in combining written mediaeval sources, archaeology and preserved monuments from the Byzantine and Ottoman periods in South-East Europe with GPS- and GIS-applications is the lack of historical topographic maps on that region. Rare are the examples of detailed maps dating to the 19th century AD of certain areas of historical Macedonia (i.e. before industrialisation evolved on a large scale in South-East Europe), which would facilitate the regressive reconstruction of mediaeval landscapes.

2. APPROACH AND METHODS

This paper focuses on a case study, which is based on maps of ‘Macedonia’s five most excellent cities’ from 1832. Initially, they were drawn by Wilhelm von Chabert-Ostland (ca. 1800-1846), then consul of the Austrian Empire in Thessaloniki, with the help of a retired Austrian officer named Joseph Seydl and submitted to the Austrian administration, namely the Haus-, Hof- und Staatskanzlei in Vienna. The consul requested the authorisation to continue his efforts in mapping South-East Europe during his official journeys. The five above-mentioned maps comprised today’s Thessaloniki, Serres, Kavala and Siderokastron in Greece as well as Melnik in Bulgaria (cf. *fig. 2*) and were copied by order of another unit of Austria’s administration, the Hofkriegsratspräsidium, in 1833. Four of the five maps of the original series as well as of the copies – with the exception of Thessaloniki – are preserved in the Viennese archives. [4]

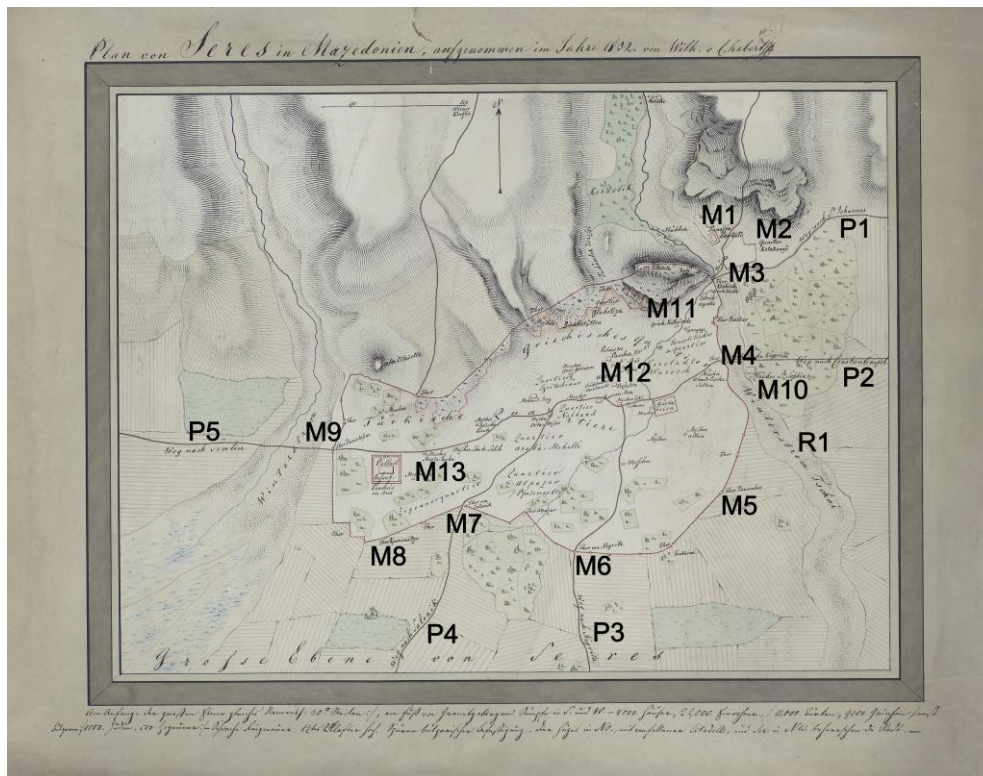


The following scientific approach is elaborated on the basis of two unpublished / not annotated maps of this collection, namely Serres and Melnik. The example of Serres illustrates the importance of the topographic aspects of this detailed map by indicating the marked Byzantine and Ottoman monuments and by identifying and localising them. This approach represents the ‘classical’ way of analysing maps.

2.1. The ‘classical’ way of analysing maps: a case study on the city of Serres

The ‘classical’ way of analysing maps consists of identifying monuments mapped by Wilhelm von Chabert-Ostland with those still preserved today in Serres as well as in the vicinity whereof. The focus primarily lies on monuments which are located outside the old city walls. The church *Panajia Leokali* (The Mother of God Heliokale; cf. *fig. 3; M1*) is first mentioned in documents dating to 1323/26 AD. In 1477 it became the property of the monastery of Kosinitza. The church itself was refurbished in the years 1785, 1805 and 1836, but destroyed in 1913. In 1938 the church and its monastery were reerected. This quarter of Serres is still known as ‘Liokale’. Another interesting toponym lies to the east of the *Panajia Leokali* and is named *Quartier Katakonomi* (*M2*). This denomination derives from a manor which was bought in

1337/38 AD by Theodora Angelina Kantakuzene, the mother of the Byzantine emperor John VI Kantakuzenos (ca. 1295-1383). Today it is completely absorbed in the quarter ‘Liokale’. To the east of the city walls one can discern a river called *Winterstrom Tschai* (**R1**). Its former name was ‘Ahmed Pasha Chay’, the Turkish word ‘chay’ meaning ‘confluent’. Today this river bears the name ‘Tzelios’ or ‘Liokale’.



The towns, villages and monasteries surrounding the city of Serres can be comprehended best by the names of its city gates. In the north-eastern part of the city walls Wilhelm von Chabert-Ostland mapped a *Thor* (gate) *Keschisch* (**M3**). Its name derives from the Turkish word ‘keshish’ meaning ‘priest’ or ‘monk’ and points to the famous monastery of St. John Prodromos (founded before 1204 AD), which lies 8 km north-east of Serres and which is indicated on the map by the route *Weg nach St. Johannes* (**P1**). A nameless gate (**M4**) is part of the eastern city wall. It lies to the south of the *Thor* (gate) *Basdar*, which cannot be identified, and it controlled the route to Istanbul (*Weg nach Constantinopel*; **P2**). In the south-eastern part of the city wall one can discern a gate called *Thor Doxambos* (**M5**), whose name derives from the village Doxompus (today Myrkinos, 31 km south-east of Serres). Three gates interrupt the city wall in the south. The first, *Thor von Negrita* (**M6**), led on the route *Weg nach Negrita* (**P3**), which can be identified with the town of Nigrita, 21 km south-south-west of Serres. The second, *Thor von Salonik* (**M7**), connected Serres with the important seaport of Thessaloniki via the route *Weg nach Salonik* (**P4**). The third gate is the *Thor Kamenitza* (**M8**), whose name derives from the Slavonic word ‘kamen’ for ‘stone’ and is still preserved in the names of two western quarters of Serres called ‘Ano Kamenikia’ and ‘Kato Kamenikia’. Last but not least, a *Thor Demirhissar* (**M9**) can be found in the western part of the city wall, which guarded the route to the city of *Semlin* (*Weg nach Semlin*; **P5**). While Demirhissar can be identified with today’s city of Sidirokastron, *Semlin* is the old name for Zemun (today a quarter of Belgrade). [5]

To the south of Serres stretches a great plain (*Große Ebene von Serres*), which covers approximately 1,400 square kilometres. It connects the city with the Aegean coast and is mentioned for the first time as ‘kampos ton Serron’ in written sources of 1376. The mosque *Sta. Sophia* (**M10**) is located in the eastern outskirts of Serres and can be identified with the current ‘Mehmet Bey Mosque’ (also called ‘Agia Sophia’). According to an inscription from 1492/93 it was erected by Mehmet Bey, son of the grand vezir Ahmet Pasha and husband of the imperial princess Selchuk Hatun, the daughter of sultan Beyazit II (ca. 1447-1512). At this point one is led to recognise immediately the invaluable information provided by Chabert’s map of Serres. A recent publication on the Ottoman edifices of Serres reports that the “stream [scilicet ‘Tzelios’ or ‘Liokale’] passes on the eastern side of the building [scilicet the ‘Mehmet Bey Mosque’], but originally it passed on the west and the area was connected to the settlement by a stone bridge, whose foundations have recently been revealed in building plots.” [6] Wilhelm von Chabert-Ostland sketches

exactly this former topographical situation. We see the river passing to the west of the mosque and we even discern the bridge named *Brücke Pascha Köprissi*, which connected the outskirts with the city itself. Thus we find current archaeological excavations and interpretations confirmed by the unique map presented here for the first time.

Turning now to the edifices within the city walls, three of them have to be highlighted. The first is mapped by Wilhelm von Chabert-Ostland as *Griech.[ische] Kathedrale (M11)*. It is today's old metropolitan church 'Hagioi Theodoroi' ('Palaia Metropolis'), which dates back to Early Byzantine times, while its present state is based upon structures of the 11th century AD. In the very centre of Serres one can discern an edifice called *Besesten (M12)*, which is an Ottoman luxury goods market dating to the end of the 15th century (circa 1494). It was built by an Ottoman officer called Ibrahim Pasha and houses today the Archaeological Museum of Serres. This short outline of the 'classical' way of analysing maps is concluded by an edifice in the western half of the city, namely the 'Mustafa Bey Mosque', which is indicated by Chabert as *Moschee Musta-Pascha (M13)*. It lies in the quarter of 'Kato Kamenikia' and was erected in 1519 by Mustafa Bey.

2.2. The 'modern' approach of analysing maps: a case study on the city of Melnik

The 'modern' approach comprises altogether four steps concerning the map of Melnik. First, the monuments on the map had to be identified with those still preserved today (as in the case study on Serres) in order to enable its georeferencing.

In the south-western part of the map one can discern the elevation 'Sveti Nikola' (Saint Nicholas) with its fortress (*Ruinen eines Kastells*), which was erected in several construction phases between the 5th century AD and the 14th century AD (cf. **fig. 4; M1**), with its old metropolitan church *St. Nikolaus* (Saint Nicholas; 12th / 13th century AD; **M2**) and its monasteries *Spileon* (The Mother of God of the Cavern; 13th / 14th century AD; **M3**) as well as *St. Taxiarch* (Holy Archangels; 13th century AD; **M4**).



On the eastern edge of the map is located the monastery *Pandanasa* (The Mother of God, Queen of all; 13th / 14th century AD; **M5**). In the city itself the new metropolitan church of Saint Nicholas named *Metropolis* (18th century; **M6**) can still be found on the northern slopes of the elevation 'Sveti Nikola'. The north-eastern part of Melnik is dominated by a clock tower (*Uhrthurm*) (today the so-called 'Boyar House'; dating?; **M7**), which has fallen into disrepair. Finally, a stone bridge, which crosses the river Melniška and probably dates back to Roman times, is located in the north-western part of the city (**M8**).

[7]

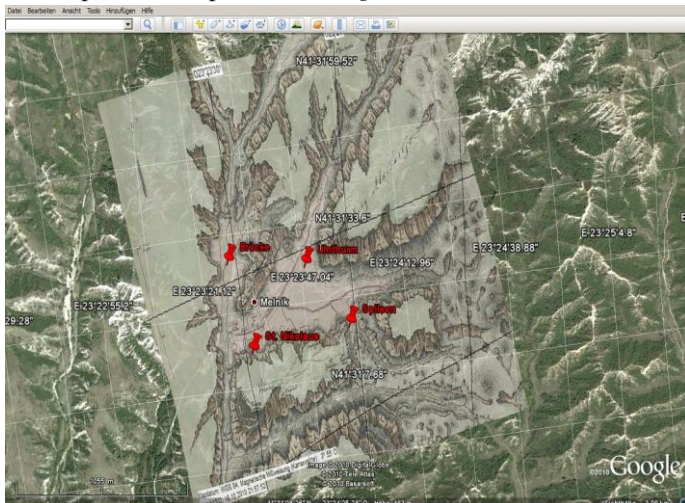
Remarkable is the fact that the Austrian consul Wilhelm von Chabert-Ostland maps a mosque in the immediate vicinity of the eastern bank of the river Melniška (**M9**). According to E. H. Ayverdi the city of Melnik even had three mosques. [8] Today only one example of Ottoman architecture is preserved, which lies to the south-west of the 'Boyar House' and whose former function could not be clarified (**fig. 5**), since it was neither mapped by Wilhelm von Chabert-Ostland nor is it mentioned in the bibliography. Its outward design implies the function of an Ottoman bath, but for a definite explanation a detailed research would be necessary.



The second step comprised the georeferencing of the map, which was accomplished on the basis of four monuments: the stone bridge (**M8**), the *Uhrthurm* (**M7**), the old metropolitan church *St. Nikolaus* (**M2**) and the monastery *Spoleon* (**M3**).

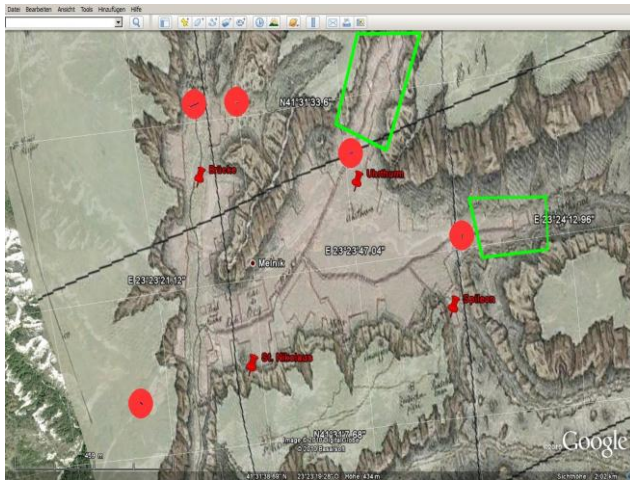
All were localised and recorded as GPS-waypoints during two surveys in Melnik in June 2007 and in June 2010. Then the software *Touratech QV 4.0.127 Test Version* was used for positioning the waypoints and for the georeferencing of the map by applying the standard *World Geodetic System 1984*.

After that the result, which showed a magnetic variation of $3^{\circ} 55' E$, was embedded into *Google Earth* (**fig. 6**). We recognise that the north-eastern, the eastern and the south-eastern parts of the georeferenced map fit very well into the existing landscape, while we face remarkable deformation in the northern, north-western, western, south-western and southern parts. In respect of the GPS-waypoints used, we see that the georeferenced map deviates only slightly compared to **M7** and **M3**, which means that the embedding of the map's eastern part into *Google Earth* has been successful.



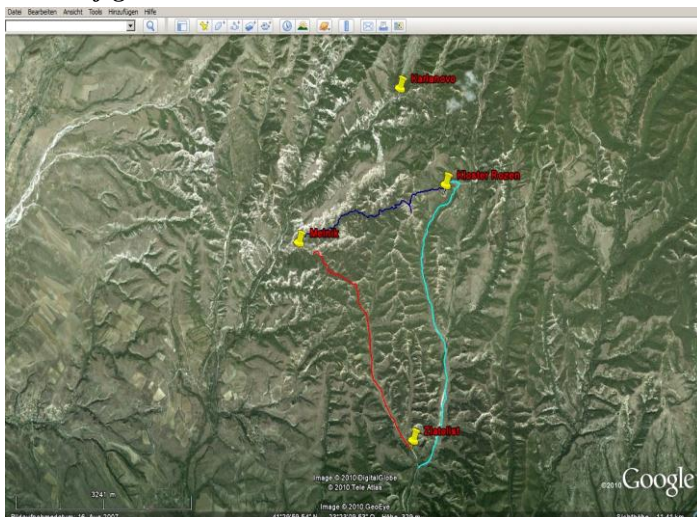
The reasons for the above-mentioned magnetic variation cannot be answered with certainty. On the one hand it could be that the Austrian consul Wilhelm von Chabert-Ostland did not draw the map's western part with correct distances and measures. On the other hand the variation could be explained with an incompatibility between the map and *WGS 84*, since Chabert did not indicate his map's projection.

The third step of the 'modern' approach consisted of a comparison between Melnik's borders in the 19th and the 21st century. Besides the above-mentioned GPS-waypoints, I have also recorded GPS-tracks of the current city's borders during surveys in June 2010, thus specifying its present settlement area. These tracks enable us to reconstruct Melnik's urban development throughout the centuries. By incorporating altogether five of them into the georeferenced map, which are marked with red circles in **fig. 7**, we obtain a direct comparison of the settlement areas now and then. Although the magnetic variation prevents us from drawing significant results from the northern, north-western and south-western parts of the map, we are able to do so in the north-eastern and eastern parts. There we can witness a remarkable loss of settlement structure in the north-eastern as well as eastern valley throughout the centuries as indicated by green rectangles (cf. **fig. 7**).



In a fourth and last step the traffic routes on the micro-level, i.e. paths and mule-tracks, were identified in the surrounding area of Melnik. All of them were systematically recorded with GPS-tracks during surveys in June 2010 (cf. *fig. 8*). If we compare them with the three routes sketched on the map from 1832, we come to the conclusion that all of them still exist and are in use today.

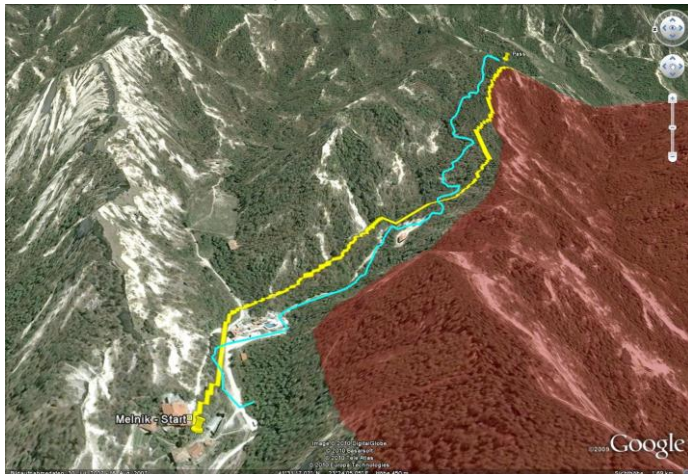
The first is named *Weg nach Seres* on Chabert's map and is indicated by the abbreviation **P1** in *fig. 4*. It can be found at the south-western entrance to the city of Melnik. This route is a tarmac road today and leads to the Bulgarian city of Petrich and from there to the Greek city of Serres. According to Wilhelm von Chabert-Ostland the second route passed through Melnik's north-eastern valley (**P2** in *fig. 4*). Today it is identical to a hiking trail between Melnik and the monastery of Rozhen, which is indicated by the blue GPS-track in *fig. 8*. Last but not least the map from 1832 shows a path named *Steig nach Nevrekop* immediately to the south of the elevation 'Sveti Nikola' (**P3** in *fig. 4*). *Nevrekop* is the old name of today's Goce Delchev, a city to the east of Melnik in the valley of the river Mesta. [9] Surveys in June 2010 have revealed that the valley to the south of the elevation 'Sveti Nikola' is totally blocked by erosion, leaving no traces of a path at all. This area is indicated as 'Zabela' in a contemporary Bulgarian map [10], which derives from the Old Slavonic expression 'zabel' for 'pasture' / 'grove' [11]. It could well be that Chabert was mistaken in mapping this path in such a length. Instead a hiking trail exists today between the city of Melnik and the village of Zlatolist via the pass Goljam Kljuch (Pass), which is marked by the red GPS-track in *fig. 8*.



This route had its origin at least in the mediaeval period, although the written mediaeval sources do not refer to this traffic relation explicitly. In order to expand further on this issue, 'least-cost path' calculations were applied to create a model, which will soon be published in the *Anzeiger der philosophisch-historischen Klasse der Österreichischen Akademie der Wissenschaften*. [12]

If we take a look at the first part of the route between Melnik and the Pass (*fig. 9*), we realise a slight difference between the existing route (in turquoise) and the calculated 'least-cost path' (in yellow). This difference (about 100 m) can be explained on the one hand by the SRTM data resolution (90 m) and its

altimetric precision (about 10 m). On the other hand we do see that the ‘least-cost path’ tends to follow either the feet or the ridges of the sandstone cliffs.



In the second part of the route between the Pass and Zlatolist (*fig. 10*) the most remarkable difference between the existing route (in turquoise) and the calculated ‘least-cost path’ (in yellow) can be discerned immediately to the south of the Pass. Surveys revealed that the computer based calculations prefer a direct way, leading south through a hollow, which could be used by a human being with difficulty, but not by pack-animals due to the slope and the dense vegetation cover. That is why the existing route leads slightly to the east and then turns south in order to neutralise the slope in this zone. Finally, we recognise a marginal difference between the two routes in the grass-covered valley towards the village of Zlatolist, which can be ignored, because the terrain is flat and allows smooth movement in the middle of the valley as well as on its edges at the feet of the sandstone cliffs.



This case study on the route Melnik-Zlatolist reveals the continuity of transportation on a micro-level through mediaeval and modern times by applying the means of replication within a ‘least-cost path’ model.

On the basis of my surveys as well as of my research so far I would like to suggest that the eastern part of the route **P3** (*Steig nach Nevrekop*), which was mapped by Wilhelm von Chabert-Ostland, could be identical in parts to the route between Melnik and Zlatolist via the Pass, while the historical existence of the route to the south of the elevation ‘Sveti Nikola’ has to be doubted strongly due to the character of the landscape in this area called ‘Zabela’. One argument in favour of my opinion are the remnants of a tower (6th century AD?), which is to be found at the Pass, which was documented by Bulgarian archaeologists [13] and which was obviously identified by Chabert with the designation *Wachthürme* (cf. the red rectangle in *fig. 4*).

3. RESULTS

The results obtained in this study illustrate that Byzantine Studies, historical geography, military cartography from the 18th century onwards and GIS can successfully be combined with the aim of reconstructing mediaeval space and place in the historical region of Macedonia. Two main obstacles arose

in the wake of this paper's development: The first enlightened that a time-consuming approach is needed in order to prepare a relatively small amount of information for GIS-application. The second issue addresses the fact that it is still very difficult for the authors as historians to inspire GIS-technicians to involve themselves in such case studies.

4. FUTURE PLANS

Despite the above-mentioned obstacles, the authors will continue their scientific work on all four valuable maps in detail and try to find further examples of similar maps from the same period to create a variety of case studies and to enrich the spectrum of this hitherto neglected interdisciplinary approach.

5. FOOTNOTES

[1] Cf. on the overall project *TIB* with further hints to the bibliography: Johannes Koder, Perspektiven der Tabula Imperii Byzantini. Zu Planung, Inhalt und Methode. *Geographia antiqua* 5 (1996), pp. 75-86; Mihailo St. Popovic, The Project *Tabula Imperii Byzantini (TIB)* of the Austrian Academy of Sciences. *Ostkirchliche Studien* 58/2 (2009), pp. 267-272; Idem, Mapping Byzantium – The Project 'Macedonia, Northern Part' in the Series *Tabula Imperii Byzantini (TIB)* of the Austrian Academy of Sciences, in: *Mapping Different Geographies*, ed. Karel Kriz, William Cartwright, Lorenz Hurni (Lecture Notes in Geoinformation and Cartography). Berlin-Heidelberg 2010, pp. 219-234.

[2] Cf. on this project in detail: <http://www.oeaw.ac.at/byzanz/routes.htm> (viewed 19 January 2011).

[3] together with Julison J. Jubanski, On the Function of 'Least-Cost Path' Calculations within the Project *Tabula Imperii Byzantini (TIB)* of the Austrian Academy of Sciences: a Case Study on the Route Melnik-Zlatolist (Bulgaria), in: *Anzeiger der philosophisch-historischen Klasse der Österreichischen Akademie der Wissenschaften*, 145. Jahrgang (2010) [in press].

[4] Cf. on the history and the archive material concerning these maps: Mihailo St. Popovic, Die fünf vorzüglichsten Städte Macedoniens auf Plänen des k. k. Konsuls Wilhelm von Chabert aus dem Jahre 1832. *Thetis, Mannheimer Beiträge zur Klassischen Archäologie und Geschichte Griechenlands und Zyperns* 16/17 (2010) [in press].

[5] On the trading routes between northern Greece and the river Danube in the 19th century: Vladimir Stojanchevic, Juznoslovenski narodi u Osmanskom carstvu od Jedrenskog mira 1829. do Pariskog kongresa 1856. godine. Beograd 1971, pp. 27, 29.

[6] Hellenic Ministry of Culture (ed.), Ottoman Architecture in Greece. Athens 2009, p. 279. Also cf. Heath W. Lowry, The Shaping of the Ottoman Balkans 1350-1550. The Conquest, Settlement and Infrastructural Development of Northern Greece. Istanbul 2008, pp. 140-175.

[7] Cf. on the monuments of Melnik the remarkable synopsis published by: Violeta Nesheva, Melnik. Bogozidaniyat grad. Sofija 2008, passim; see also: Mihailo Popovic, Zur Topographie des spätbyzantinischen Melnik. *Jahrbuch der Österreichischen Byzantinistik* 58 (2008), pp. 107-119.

[8] Ekrem Hakkı Ayverdi, Avrupa'da Osmanlı Mimârî Eserleri. Bulgaristan, Yunanistan, Arnavudluk. IV. Cild, 4.,5.,6. Kitap. Istanbul 1982, p. 69.

[9] Petar Koledarov, Nikolaj Michev, Promenite v imenata i statuta na selishtata v Balgarija 1878-1972 g. Sofija 1973, pp. 76f.

[10] Map 1 : 55,000. Turisticheska karta, Pirin. Sofija 10th ed. 2006.

[11] Milosh Blagojevic, Srednjovekovni zabel. *Istorijski chasopis* 14-15 (1966), pp. 1-17.

[12] Cf. footnote [3].

[13] Cvetana Komitova, Arheologichesko prouchvane na obekt 'Krepostna kula' v m. Kljuch kraj gr. Melnik, in: Arheologicheski otkritija i razkopki prez 2003 g. Sofija 2004, pp. 199f.; Nesheva, Melnik. Bogozidaniyat grad, pp. 62, 70f.

6. CAPTIONS

fig. 1 Leaflet of the Institute for Byzantine Studies of the Austrian Academy of Sciences illustrating the progress of the TIB. Source: Institute for Byzantine Studies of the Austrian Academy of Sciences, designed by Elisabeth Ch. Beer, revised by Christian Gastgeber

fig. 2 The cities Thessaloniki, Serres, Kavala and Sidirokastron in Greece as well as Melnik in Bulgaria. Source: Mihailo Popovic

fig. 3 Österreichisches Staatsarchiv (OeStA) / Haus-, Hof- und Staatsarchiv (HHStA) Ke 3-7/7, Festungen 1832, Mazedonien. Layer: Peter Soustal

fig. 4 OeStA / HHStA Ke 3-7/7, Festungen 1832, Mazedonien. Layer: Mihailo Popovic

fig. 5 The Ottoman bath (?) in Melnik (Bulgaria). Source: Mihailo Popovic (TIB 16)

fig. 6 OeStA / HHStA Ke 3-7/7, Festungen 1832, Mazedonien and © 2010 Google, © 2010 Tele Atlas, Image © 2010 DigitalGlobe, © 2010 Basarsoft. Layer: Mihailo Popovic

fig. 7 OeStA / HHStA Ke 3-7/7, Festungen 1832, Mazedonien and © 2010 Google, Image © 2010 DigitalGlobe, © 2010 Basarsoft. Layer: Mihailo Popovic

fig. 8 © 2010 Google, © 2010 Tele Atlas, Image © 2010 DigitalGlobe, Image © 2010 GeoEye. KML Layer: Mihailo Popovic

fig. 9 © 2009 Google, © 2010 Tele Atlas, © 2010 Europa Technologies, Image © 2010 DigitalGlobe, © 2010 Basarsoft. KML Layer: Juilson J. Jubanski

fig. 10 © 2009 Google, © 2010 Tele Atlas, Image © 2010 DigitalGlobe, © 2010 Basarsoft. KML Layer: Juilson J. Jubanski

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