

Chapter 71

The Austro-Hungarian Triangulations in the Balkan Peninsula (1853–1875)

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Abstract

The Turkish part of the Balkan Peninsula was an area of extent geodetic surveys between 1853 and 1875. These works were carried out by the Austro-Hungarian authorities, partially in the frame of the International Arc Measurements (*International Gradmessung*). These activities were made in the present territories of Bosnia-Herzegovina, Albania, Montenegro, southern Serbia and Kosovo, Bulgaria, southern Romania, Macedonia and also the northern Greece. Astronomical points were measured throughout the area, mainly along travel routes of the surveying parties, and then other points, mainly mountain peaks, were determined by triangulation (intersection) from the astronomical points. No geodetic network adjustment was applied to the point sets. Based on these geodetic base point data, 1:75,000 scale maps of the Austro-Hungarian Monarchy was issued from the 1880s to the WWI, as well as local Serbian maps after the independency of the state. The existing geodetic datasets was the base of the utilization of the Hermannskogel datum in the later Yugoslavia, even the territories that were not part of the Habsburg Empire. For present GIS applications it should be underlined, that the Yugoslav version of the Hermannskogel datum used different Ferro-Greenwich longitude shift, thus the datum description parameters differ from the ones used in Austria.

Keywords: historical geodetic surveys, Balkan Peninsula, Habsburg cartography, European Arc Measurements, Turkish Empire



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71.1 Introduction

There are many printed map sheets; some of them are available in the antiquary book shops throughout the Central Europe that show the Habsburg Monarchy and the adjacent territories prior to the WWI. A series of these sheets, issued after 1880, is available in geo-referred form in DVD (Biszak et al., 2007). Besides, a whole series of maps in 1:200,000 scale, covering even larger parts of Central Europe and the Balkans were issued around 1910 by the Austro-Hungarian cartography (Crăciunescu, 2006; Jankó, 2007; Timár et al., 2009). The accuracy of these sheets is quite surprising at the technology level of the production period. Except some sheets with obvious blunders and errors over kilometer-level, most maps can be rectified with an error not more than a quarter kilometers (Molnár & Timár, 2009). Some maps were published by the Romanian authorities in 1:75,000 scale (Osachi-Costache, 2000; Mugnier, 2001; Rus, 2008; Timár & Mugnier, 2009) and in the same scale, by the Serbian Institute of Military Geography (Kovács, 2009), also prior to the WWI.

A simple question arises about these products: how could the Military Geodetic Institute (MGI) of the Habsburg Empire gather the necessary geodetic data to compile these maps? It is obvious that these accurate maps could not be made without geodetic basis. In the 19th century, the countries and empires seldom let geodetic surveyors from other lands to enter and work in their own territory. Making military maps was always a part of military preparation to operate (in other words: to invade) the mapped area. The Turkish (Ottoman) Empire was somewhat friendly to the Habsburg though they were not allies. Later, the newly independent Balkan states were rather hostile ones to the Austrians. How could the MGI manage this work under these circumstances? Or was the geodetic survey made by the Turks or the Balkan states, and the Austrians spied the results? An archive query in the Austrian State Archive (ÖStA Kriegsarchiv) assures us that the survey was made by the Austrians themselves. A series of reports describe this huge project.

71.2 The historical background of the Balkan surveys

In the 19th century, the European borders and the sovereignty of many lands changed much more frequently than is usual nowadays. In the middle of the continent, the Habsburg Empire always played an important role in any hostilities. This was resulted not only in the frequent change of the Habsburg borders but also in occupying – at least temporarily – many important pieces of land. During these ‘visits’, they started to survey these territories. As a result, we can find coordinate lists for the whole Italian peninsula in the Military Archive in Vienna (see e.g. MGI, 1853).

Concerning the Balkans, the role of the Austrians there is more important. When Russia occupied the Danube Principalities (the Old Romania) in 1853, the Turco-Russian tension led to the Crimean War. During this war, Austria forced its former ally, Russia, to give up this occupation, and Austrian armies took their place between 1854 and the Paris conference resolving the peace at the end of Crimean War. The MGI the time and made a whole geodetic survey in Wallachia (Oltenia and Muntenia) and Northern Dobrogea. This survey was the first systematic geodetic triangulation in Romania (Timár, 2008).

If you are a geodetic surveyor and you are not let entered to a country to work, some tricks could be used to get the permission, without using an occupation. Although no evidence exists about this, the authors think that the Central European Arc Measurement, later the European Arc Measurement (*Mittel-Europäische Gradmessung* and *Europäische Gradmessung*, respectively; Kretschmer et al., 2004), brokered by the Prussians in the 1860s, had this reason behind the curtain. These projects aimed to determine the real and accurate size and shape of the Earth. However, not all European countries were prepared to make the necessary measurements and provide them to the community. This could be a possibility for the Austrians to offer their help to the Turkish Empire to make the necessary measurement. Whatever was the background, the Turkish authorities entered the Austrian survey teams to the European parts of the empire (Fig. 71.1), and the survey was made between 1871 and 1875 in the whole European territory of the Turkish Empire (Ganahl & Sterneck, 1871; 1872a; 1872b; 1874; Ganahl & Milinkovič, 1873; Ganahl & Gyurkovics, 1873; Ganahl & Hartl, 1875; Fig. 71.2).

It was almost the last moment to do it. The tension between Russia and Turkey broke out in a new war in 1878. The Congress of Berlin, resolving the peace after the hostilities, let the Serbs and the Bulgarians to form their own countries. As Serbia sought for any possibility to unite all southern Slavs into a country (in the later Yugoslavia), it was a ‘natural’ enemy of the actual ruler of many claimed territories, the Habsburg Empire. The tension was increased further by the occupation of Bosnia-Herzegovina by the Austro-Hungarian Monarchy. No further Austrian surveys were made prior to the WWI here.

71.2.1 Technology of the survey

The surveys were based in two different methods:

- estimation of astronomical coordinates, usually in towns, and
- estimation of coordinates of fairly visible locations, mostly mountain summits, by triangulation (intersection) from the astronomic base points.

During the astronomical measurements the latitude and longitude of the points were determined separately. The latitude was estimated by measuring the elevation

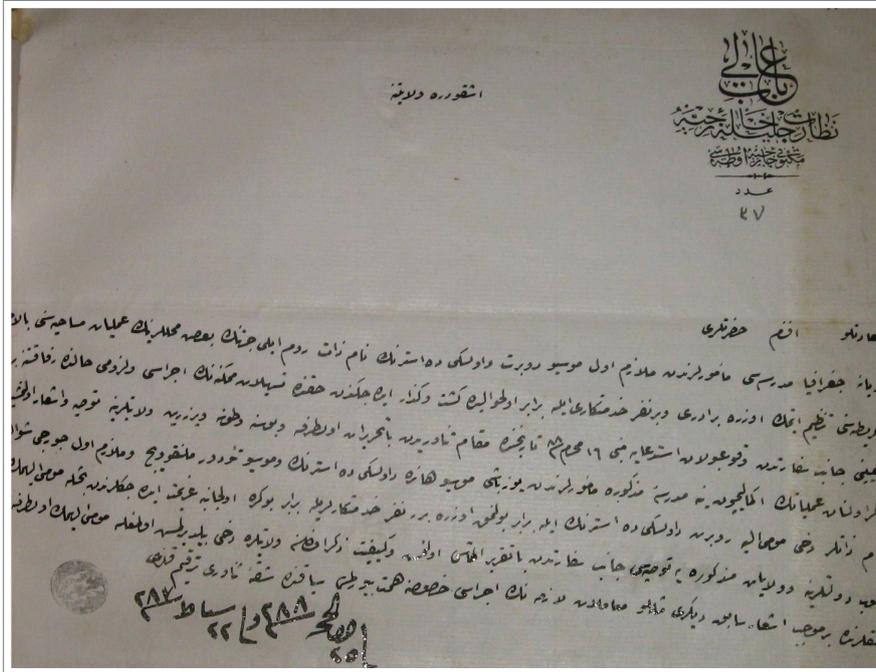


Fig. 71.1. The *ferman* (Turkish: permission, document) of the *pasha* (Turkish: governor) of Sarajevo from 1871, permitting the mapping of the Austrian surveyors (from Ganahl & Sterneck, 1872b).

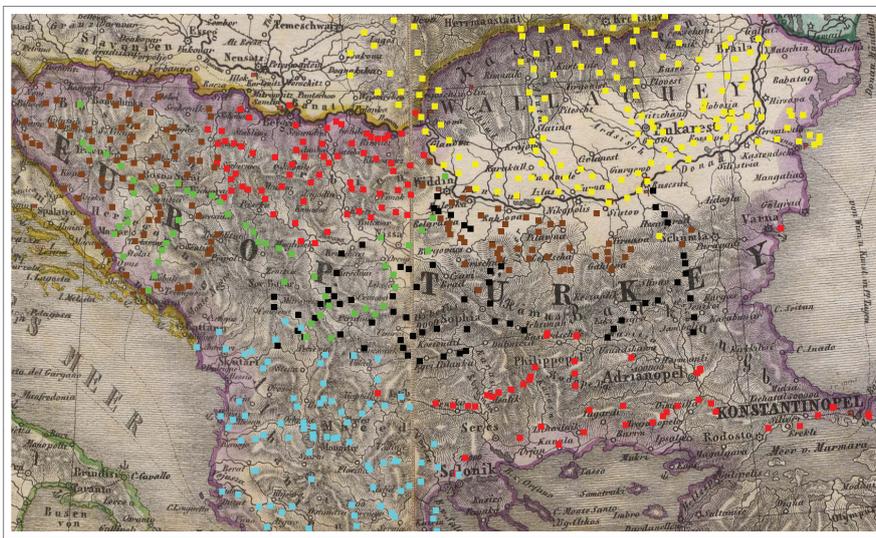


Fig. 71.2. Habsburg geodetic surveys in the Balkans, color codes: yellow: the Wallachian triangulation (1855-57, in connection with the Crimean War); green: 1871; brown: 1872; cyan: 1873; red: 1874; black: 1875.

Resultate der Beobachtungen

Name der Station	Bestimmung der Zeit					Bestimmung der geographischen Breiten					Ausgewählte Resultate		Bemerkungen			
	Tag	Tag	Monat	Jahr	Beobacht. Uhr	Tag	Tag	Monat	Jahr	Beobacht. Seite	Correction des Chronometers	Geograph. Breite		Longitude		
Bar	7. Mai		1858	2	12	+ 10	17.9					+ 10	12.7			
Ljutari	12. Mai		1858	7	12	+ 12	19.6					+ 12	20.1			
				8	12		20.1									
				9	13		20.2									
Puzos	17. Mai		1858	40	12	+ 13	39.1	15. Mai	1858	11	12	+ 13	39.1	-0.7	42 4 59	
	18. Mai		1858	42	13	+ 13	59.3					+ 13	59.2	-0.8		
Puzos				43			6									
				45			15	51.2	15. Mai	1858	17	12	+ 15	51.2	-0.5	42 6 27
				45			12	51.6								
Puzos	16. Mai		1858	17	12	+ 17	37.8	16. Mai	1858	19	12	+ 17	37.9	-0.6		
				18			37.9									
	18. Mai			20		+ 17	59.8	18. Mai	1858	22			+ 17	59.8	-0.7	
				21			59.8									
				24			18	7.0					+ 18	6.6	+3.3	
Puzos	24. Mai		1858	29	12	+ 18	25.3					+ 18	25.3	+3.0	42 12 13	
				40			25.3									
	23. Juni		1858	174	13	+ 23	35.7					+ 23	36.1	-0.7		

Fig. 71.3. Results of astronomical observations at different locations (Ganahl et al., 1899-1900).

of the North Star in the night and the Sun at local noon. Auxiliary information about culmination of other stars were used for obtain more precision (Fig. 71.3). The longitude was derived from time measurements of different chronometers at the local noon. The longitudes are given mainly from Ferro but in Macedonia and Greece (Ganahl & Gyurkovics, 1873), Rumelia, Turkey, and in the summary of Serbia (Ganahl & Hartl, 1875) they are given from Paris. The longitude difference between these prime meridians is 20 degrees in round numbers, which is the real definition of the Ferro prime meridian. The drift of the chronometers were clearly noted (Fig. 71.4). Although it does not concern the horizontal control of the network we mention that the altitude determination at these points was mostly based on barometric method.

From the astronomical base points, azimuth and sometimes elevation angles to the summits (later used as trigonometric base points) were measured and noted. In many cases, the skyline was also drawn in the protocol, with surprising accuracy (Fig. 71.5). Location of these summits was determined during the winter office work, using these observations.

The results of these methods are burdened by several error sources. The main factor of them is the real potential field shape of the Earth. Deflections of vertical occur as positional error of the points in a range of several arc seconds. We could not find any notes about real geodetic adjustment in the Balkans.

71.3 The resulted data sets and maps

The structure of the numerous reports is mostly identical, following a protocol of the measurements. The content page of Ganahl et al. (1899-1900) shows this usual structure (Fig. 71.6). It starts with the description of the background and the process of the measuring campaign. It followed by the collected data about the chronometer corrections and drifts, and the results of the longitude estimations, and the list of the geographic positions of the base points – different lists for the astronomically and trigonometrically measured points.

These core data are followed by the systematic details of the calculations (“Berechnungen”) of the astronomical, the trigonometric and the barometric data. As the longitude determinations were given in the core part, the calculations of determination of the latitude using the North Star and the zenith distance of the Sun are listed here. In the trigonometric part, first, the calculations of the triangles are given, followed by the determinations of the azimuths. The last two subsets here are the calculations of the geographic positions and the heights of the trigonometric points.

In the part about the barometric data, time series of some fixed stations are first listed, followed by the calculations (estimation) of the heights of the base points, and the results. Although the order of these data items can vary from report to report, they are given in them. E.g., sometimes the list of the geographic coordinates is given at the very end of the report under the title of Results (“Ergebnisse”) but sometimes at the end of the core part, before the calculations. The results are always given separately for the astronomically measure points and for the trigonometrically derived ones.

The base points covered practically the whole European part of the Turkish Empire in 1871-75 (Fig. 71.2). The density of the points, however, are different; the point density is relatively high in Bosnia, Serbia and NW Bulgaria, medium in Albania, Macedonia and northern Greece and quite low in South Bulgaria (Rumelia) and around Constantinople (Istanbul). We found almost no data about the Bulgarian coastal zone and about central Greece (along the Turkish-Greek border of that period). In the Old Romania, a frame of geodetic points was developed, consisting of four triangle chains along the main rivers. The cartographic products, listed in the Introduction, were developed using this geodetic datasets. The 1871-72 survey of Bosnia was soon obsoleted by the new Habsburg measurements after the 1878 occupation of this land, incorporated in the survey and results of the whole Monarchy (MGI, 1901), defining the Hermannskogel datum for all parts of the empire.

<i>Inhalt.</i>	
<i>Berichte</i>	<i>Seite</i>
<i>Arbeits-Journal</i>	3
<i>Resultate der Berechnungen</i>	31
<i>Zusammenstellung der berechneten Uhr-Correctionen und Breiten</i>	35
<i>Schemata zur Ausgleichung der Chronometer-Gänge</i>	37
<i>Grafische Darstellung der Chronometer-Gänge</i>	41
<i>Berechnung der Längen</i>	45
<i>Geografische Positionen der astronomisch und trigonometrisch bestimmten Punkte</i>	47
<i>Berechnungen</i>	51
<i>a. Bestimmung der Breite durch den Polarstern.</i>	57
<i>b. Bestimmung der Breite durch Circummeridian-Zenith Distanzen der Sonne</i>	107
<i>c. Bestimmung der Zeit aus gemessenen Zenith Distanzen</i>	163
<i>Trigonometrisch bestimmte Punkte.</i>	
<i>a. Berechnung der Dreiecke.</i>	213
<i>b. Berechnung der Azimuthe</i>	313
<i>c. Berechnung der geografischen Positionen</i>	327
<i>d. Berechnung der trigonometrisch bestimmten Höhen</i>	361
<i>Barometrische Höhen-Bestimmung</i>	377
<i>Barometer Lesungen auf den Stationen Agram, Orsova und Durazzo</i>	379
<i>Berechnung der Höhen der Hauptstationen</i>	383
<i>Höhen der Hauptstationen.</i>	391
<i>Barometrisch bestimmte Höhen.</i>	395

Fig. 71.6. The content page of Ganahl et al. (1899-1900) shows the usual items of information given in these datasets.

71.4 Summary

The military cartographic survey of Austria-Hungary made a tremendous effort to survey most of the Balkans, in two waves. Geodetic base points in Old Romania were measured during the 1855-57 occupation connected to the Crimean War.

Survey of the Balkans was carried out between 1871 and 1875, providing several hundred base points throughout the European territory of the Turkish Empire, possibly in connection with the European Arc Measurements. This dataset was used for the compilation of the 1:75,000 and 1:200,000 scale Habsburg maps, as well as the 1:75,000 scale maps of the newly independent Serbia and Romania. The usage of the Hermannskogel datum in Yugoslavia (and in the former Yugoslav republics even nowadays; Mugnier, 1997) is based not only on the surveys made in the Austria-Hungary prior to the WWI but partially on these early measurements.

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Note on the References: In case of the MGI reports of the Balkan triangulations from 1871-1875, the real authors are not indicated. The names mentioned in the references, however, are indicated in the title pages. Colonel *Johann Ritter von Ganahl* was the Triangulierungs-Director of the MGI in this period and the second names refer to the commanders of the survey units involved in the work.

