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The Habsburg geodetic surveys of the Balkans (1873/75) and the early topographic maps of Northern Greece

Keywords: historical maps, topographic maps, Austrian Balkans surveys, georeferenced, Northern Greece

Summary: Partially in the frame of the Middle European Degree Survey, the Austrian military topographic service surveyed the European part of the Ottoman Empire, between 1871 and 1875. The surveys, allowed officially by the Ottoman authorities, were conducted by astronomical observations and chronometric measurements to estimate the astronomical coordinates of some basepoints in towns and in valleys. These data were completed by observations providing the azimuth of lines to mountain summits. Coordinates of these peaks were later calculated by triangulation. The results of the surveys are stored in the Military Archive of the Austrian State Archives in Vienna; the pages, concerning the points in Greece are published in this contribution. Besides, we make an attempt to find correlations of these astronomical originated (not adjusted) coordinates and the later 1:50k, 1:75k and 1:200k Greek and Austrian maps of Northern Greece.

Balkan surveys of the Austrian Institute of Military Geography

From 1871 to 1875, the Military Geographical Institute (Militär-Geographische Institut) in Vienna carried out a series of surveys of the then Ottoman territories of the Balkans: Bosnia, Serbia, Bulgaria, Albania, the Vardar region and the still occupied territories of modern Greece. The eastern endpoint of the survey was at Constantinople (Kovács & Timár 2010). The survey can be considered as a rapid one. In the river valleys, in towns easily accessible by main roads, astronomical positioning was carried out, and longitude differences were measured by chronometer. The directions of the characteristic summits were determined from these points, so that their coordinates were estimated by triangulation during the winter office activity. The coordinates of the points were given on point lists. Latitudes and longitudes are given in degrees; altitudes are given here in metres. The longitude difference values are given relative to the Paris prime meridian, which is exactly 20 degrees east of the Ferro starting meridian used in Austrian and German cartography (Timár 2007; Withers 2017). The modern value for the Paris–Greenwich longitude difference is 2d 20m 14.025s. An interesting question is what might have been the reason for the Ottoman licence given to the Austro-Hungarian surveyors. It is possible that the eastern extension of the Central European and later European Arc Measurement (Europäische Gradmessung), organised by Baeyer (1861), was the reason for the survey. In addition to the above, in 1885 the Austrian cartography produced the first unified 1:300,000 scale map of Greece (Livieratos 2009), which obviously required some kind of rapid survey, but no archival trace of this has been found in Vienna. Although it shows Greece, the map was drawn in the Bonne projection with a Vienna starting point.

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Figure 1: New borders in the Balkans after 1878. The 1871–75 Austrian surveys cover the Ottoman territory of Balkan region prior to 1878 (blue borders) minus Romania, which was already surveyed during the Crimean War.

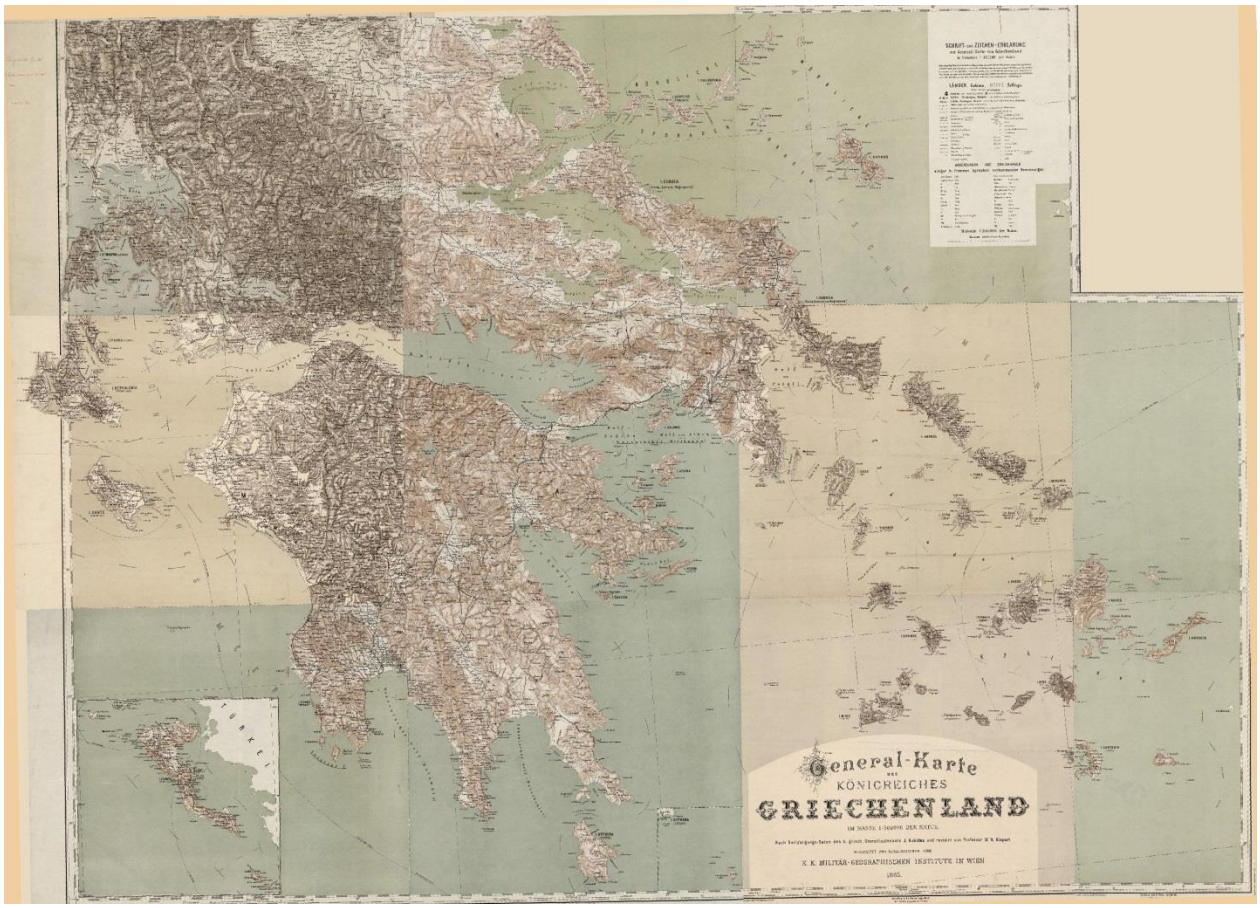
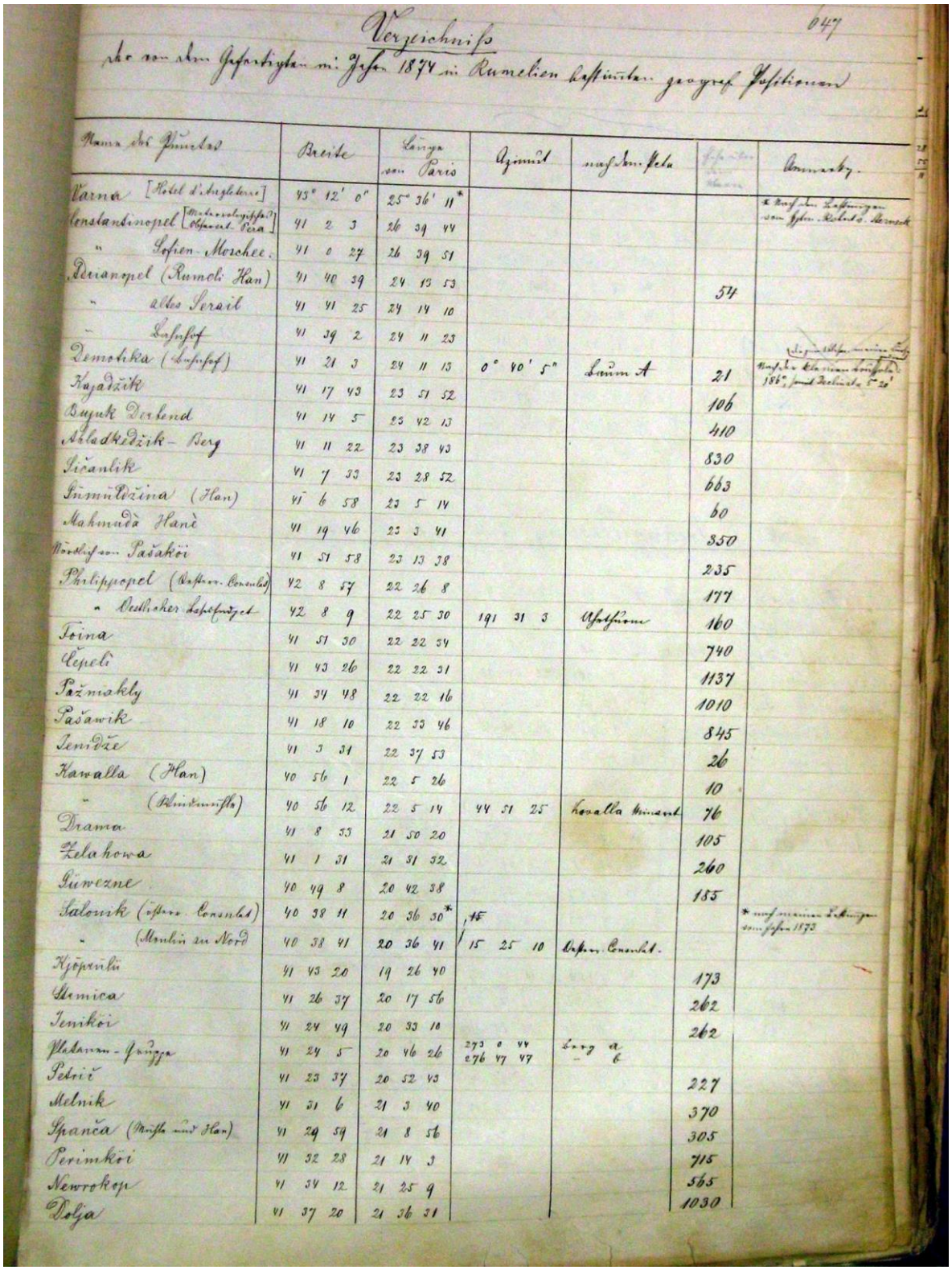


Figure 2: The Austrian 1:300,000 scale map of Greece, georeferenced in Vienna-centered Bonne projection. The exact horizontal and vertical sheet boundaries indicate the correctness of this projection.

Greek cartography from the Congress of Berlin to the Balkan Wars

The international situation made it impossible for the Austro–Hungarian survey to continue after 1875. In 1878 most of the survey area became a theatre of the Russo-Turkish War. Bosnia and Herzegovina was invaded by the Monarchy at the end of the year, Serbia and Bulgaria later became independent states in the northern part of their modern territory, and Montenegro also gained some lands as a result of the Ottoman military defeat. Although the Greeks also hoped for territorial gains, this did not happen at the Berlin Congress in 1878, which closed the war. The Greek–Ottoman border was nevertheless clarified, and its cartographic survey was a significant step in the development of Greek cartography (Livieratos 2009).

In the present work, we focus on the territory that was under Ottoman/Turkish rule in 1878 (and before), and which was ceded to Greece as a result of the Balkan War of 1912. In this area, we find Austro–Hungarian survey points, and both Austrian and Greek mapping was carried out in the area. However, the point density reconstructed from the documents found so far in the Vienna archives is not uniform and is clearly not sufficient even for the geodetic system of a small-scale topographic cartography.



Verzeichniss 647

Name des Punktes	Breite	Länge von Paris	Azimut	nach Station		Anmerkg.
Varna [Hotel d'Angleterre]	43° 12' 0"	25° 36' 11"*				
Constantinopel [Marineobservatorium Pera]	41 2 3	26 39 44				
" Sofien-Moschee	41 0 27	26 39 51				
Adrianopel (Rumeli Han)	41 40 39	24 13 53			54	
" altes Serail	41 41 25	24 14 10				
" Bahnhof	41 39 2	24 11 23				
Demotika (Bahnhof)	41 21 3	24 11 13	0° 40' 5"	Baum A	21	
Kajadžik	41 17 43	23 51 52			106	
Buyuk Derbend	41 14 5	23 42 13			410	
Arkadedžik-Berg	41 11 22	23 38 43			830	
Sičanlik	41 7 33	23 28 52			663	
Šumnidžina (Han)	41 6 58	23 5 14			60	
Mahmudà Hanè	41 19 46	23 3 41			350	
Nördlich von Pašaköi	41 51 58	23 13 38			235	
Philippopel (Oesterr. Consulat)	42 8 57	22 26 8			177	
" Südlicher Bahnhofhügel	42 8 9	22 25 30	191 31 3	Observatorium	160	
Toina	41 51 30	22 22 34			740	
Čepeli	41 43 26	22 22 31			1137	
Pažmakly	41 34 48	22 22 16			1010	
Pašawik	41 18 10	22 33 46			845	
Jenidže	41 3 31	22 37 53			26	
Kawalla (Han)	40 56 1	22 5 26			10	
" (Windmühle)	40 56 12	22 5 14	44 51 25	Kavalla Minaret	76	
Drama	41 8 33	21 50 20			105	
Zelahowa	41 1 31	21 31 32			260	
Güwezne	40 49 8	20 42 38			185	
Saloniki (österr. Consulat)	40 38 11	20 36 30*	15			* nach neueren Bestimmungen vom Jahre 1873
" (Minaret zu Nord	40 38 41	20 36 41	15 25 10	österr. Consulat.		
Kjöprülü	41 43 20	19 26 40			173	
Stemica	41 26 37	20 17 56			262	
Jenikoi	41 24 49	20 33 10			262	
Vladowa-Planina	41 24 5	20 46 26	273 0 44 276 47 47	Berg a. b.		
Petrič	41 23 37	20 52 43			227	
Melnik	41 31 6	21 3 40			370	
Spanča (Moschee und Han)	41 29 59	21 8 56			305	
Perimkoi	41 32 28	21 14 3			715	
Nevrokop	41 34 12	21 25 9			565	
Dolja	41 37 20	21 36 31			1030	

Figure 3: Point list of the 1874 Austrian survey of Rumelia. Longitude values are indicated from Paris prime meridian, elevations are in meters (Ganahl & Hartl, 1875).

Georeferencing of Austrian and Greek 1:200,000 map works

In the late 19th and early 20th centuries, Europe's first medium-scale, unified system of topographic cartography was produced at a scale of 1:200,000. In the system used by Austro–Hungarian military

cartography, the sections were drawn in degrees of latitude and altitude, that's why they are also called as 'degree maps'. The section numbers referred to the coordinates of the centre of each section, with longitude values counted from Ferro – for example, the section number for Ioannina and its region was 39-40, indicating that the centre east of Ferro was 39 degrees longitude and 40 degrees latitude north. Each section had its own projection, which can be described by the Oblique Stereographic projection fitted to the section centre (Timár et al. 2010). The geodetic datum used is not clear: the areas systematically surveyed by Austro-Hungarian cartography are Hermannskogel datum, but this was apparently not available in the Balkans and Greece. A topographic map at a scale of 1:200,000 was also produced by Cartographic Service of the Hellenic Army and printed in Vienna. The latter versions were produced before 1912, when part of the area depicted was still under Ottoman rule. This idea is supported by the good Greek–Austrian cartographic relations of the time (Greek maps on an Austrian base; Livieratos 2009) and the clear similarity of the cartographic content.

The georeferencing was carried out based on the corner points of the maps. In the above system, the values of the halving parallels and meridians between the integer degrees are given as geographic coordinates, and the longitude values are reduced by 17.66278 degrees to give them in Greenwich longitudes. The corner points, thus described by their geographic coordinates, have been converted to the sheet's own Oblique Stereographic system. As the geographic coordinates were interpreted in WGS84, the fitting was obviously affected by an error in the geodetic datum. This did not exceed 500 metres for either the Austrian or the Greek sections.

Georeferencing of Greek 1:75,000 map sheets and their 1:50,000 enlarged versions

The real interest for our work was the georeferenced of the series of sections of Greek cartography depicting the border area, produced just before the Balkan War (1908–1912). Some of these sections were already exhibited at the CartoHeritage workshop in Cluj-Napoca in 2022 and have since been made available on the website of Cholnoky Map Collection (Bartos-Elekes 2008).[5] These maps show part of the pre-1912 Greco–Ottoman border region in black and white and at a scale of 1:50,000. Map sections of the same area were also produced in colour at a scale of 1:75,000. According to Livieratos (2009), the surveying and mapping procedure for these sections was adapted from the technique used in Austrian military cartography for the 1:75,000 scale version of the so-called Third Military Survey (Kretschmer & al. 2004; Molnár & Timár 2009). The section boundaries of the maps are accordingly parallel circles and meridians. In fact, as in the Austrian version, too, instead of parallel circles, straight lines connecting corner points are used as section boundaries. However, the resulting error due to the neglect of string heights is very small, around 30–50 m, and does not much interfere with the representation (Čechurova & Veverka 2009). The longitude of the section boundary meridians is given by a round and a half degree from the starting meridian in Athens. The Athens prime meridian itself was applied with a value of 23d 43m 12s from Greenwich as given on the map sections.

[5] General information of the exhibition: https://cartography.web.auth.gr/ICA-Heritage/Cluj-Napoca2022/exhibition-cholnoky-final.pdf
Downloadable maps on the website of the map collection: http://cholnokymaps.gis-it.ro/ , identifier of the sections: 21-0876.

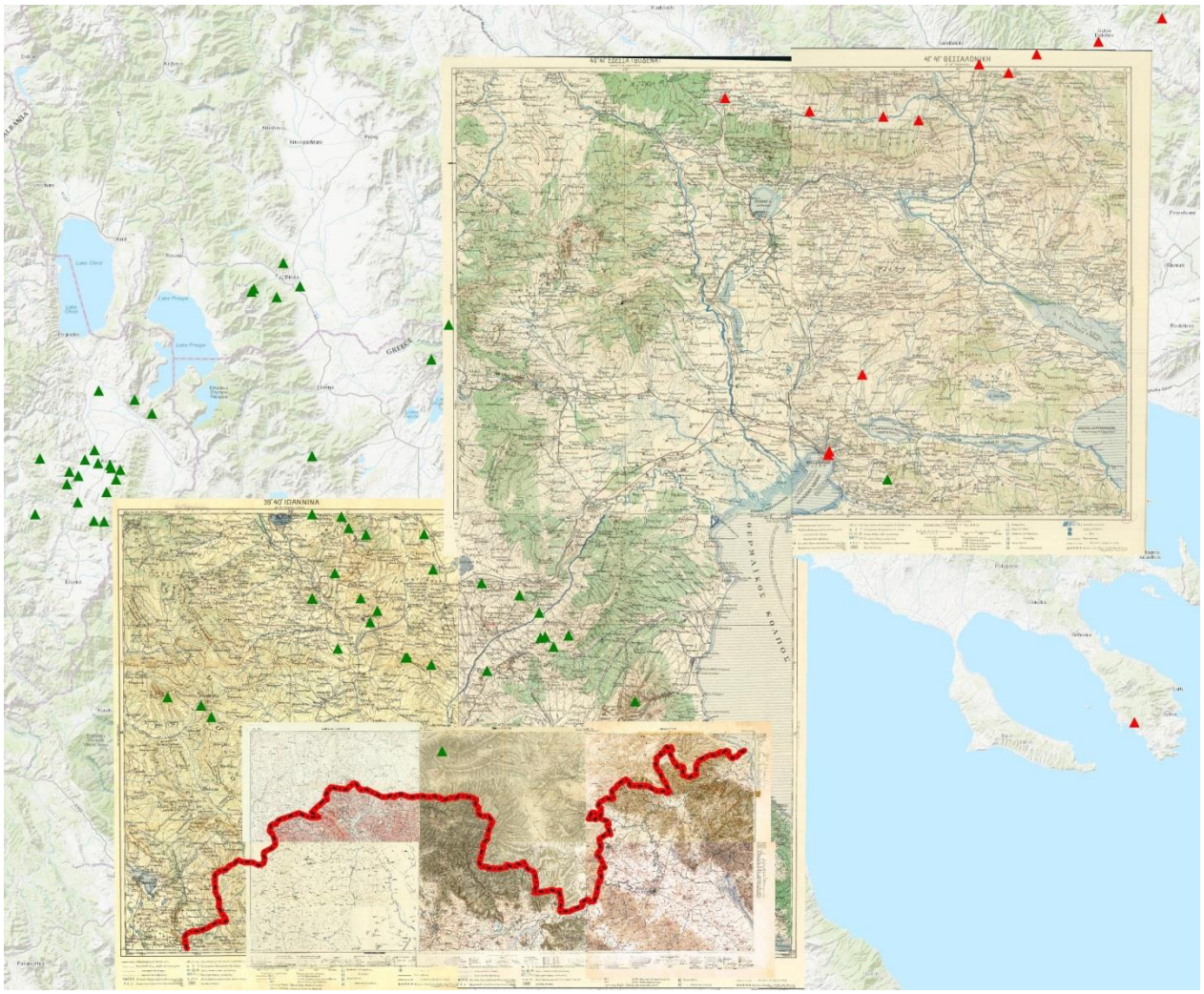


Figure 4: The lands north of the red-indicated Greek border were under Ottoman rule prior to 1912. Georeferenced Greek 1:200,000 and 1:75,000 sheets are fit to the OpenTopoMaps. Red triangles show the Rumelian points of the 1874 survey (see Fig. 3), while the green ones show the trigonometric points of the Austrian surveys.

When georeferencing the map layers, both the 1:75,000 scale colour and the 1:50,000 scale black and white versions were again based on the coordinates of the corner points. To the longitude values we added the Athens–Greenwich difference mentioned above (23.72 decimal degrees). The corner point coordinates were converted to the Oblique Stereographic projection given by the centre of the 1:200,000 scale sections for the area (cf. Molnár & Timár, 2009) and the georeferenced sheets were then projected into a common coordinate system. The georeferencing also confirmed the fact, which is obvious at a glance, that the 1:75,000 and 1:50,000 scale sections represent the same plane grid in the same coordinate system.

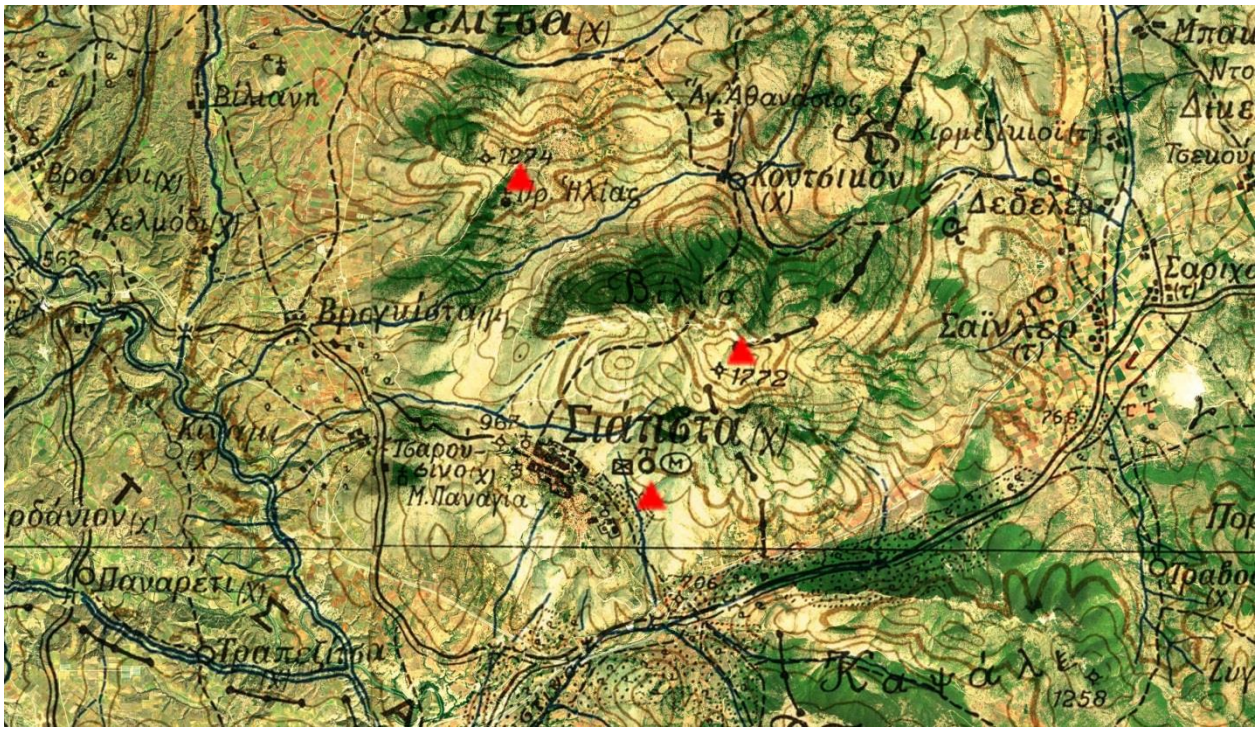


Figure 5: Triangulation points (red triangles) from the Austrian point lists, plotted over the Greek "39-40 Ioannina" 1:200,000 sheet and the modern satellite image. The accuracy of the horizontal control is about 500 meters.

Horizontal control: fit of the georeferenced sheets to the present-day terrain and Austrian survey points

For the sections published by Greek cartography, there are obvious differences in accuracy in favour of the pre-1912 Greek areas. In the case of the larger scale map works, the maps are also more detailed in these areas. It is interesting to note that although the topological correctness of the water and valley network is preserved, the course of rivers and roads in the areas under Turkish control during this period is often shown on the map in a very simplified way. Thus, these sections, although suitable for the movement of infantry units, are clearly not suitable for indirect artillery fire control. Not only because the sections, which are in a conformal projection, do not have any projection coordinate description, but also because the terrain depicted is in many cases unacceptably inaccurate, due to the lack of field survey and correction.

The only base point in the Austrian survey of the early 1870s that falls on Greek 1:75,000 maps is nevertheless reasonably accurate. The majority of the other points recognisable on the 1:200,000 sections follow the horizontal control of the sections well: using the same – but obviously not the original – geodetic datum, the map and the point network follow each other much better than any modern topography. This is an indication that the base point network was used in the development of the geodetic basis for the 1:200,000 scale series, although it was clearly not sufficient in itself.

Figure 6: Part of the "Koniskos-Elasson" (1909) 1:75,000 sheet as an overlay on the modern OpenTopoMaps. Note that the SW corner was Greece that time: the map is considerably more detailed there. The river in the northern part of the image does not fit to its real course indicated by the modern map. However, the peak near to the NW corner fits almost exactly, as well as the original Austrian survey point on it.

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