ANTAL ANDRÁS DEÁK

THE MINERAL MAPS OF L. F. MARSIGLI AND THE MYSTERY OF A MINE MAP

I have written about the results of my research on Luigi Ferdinando Marsigli[1] in my books "Discovery of the Danube"[2] and "Maps from under the Shadow of the Crescent Moon"[3]. In the first I elaborated on the history of L.F. Marsigli's Danube Monograph[4] 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.[5] 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. Below we will briefly outline the background history of the origin of the maps, and then we will take a closer look at their special qualities and points of interest.

Antonio Zanchi – Antonio Calza:

1 Luigi Ferdinando Marsigli, 1659 – 1730

2 Deák, Antal András: Dicovery of the Danube. Budapest, 2004. p. 439. (The History of the Danubius Pannonico-Mysicus).

3 Deák, Antal András: Maps from under the Shadow of the Crescent Moon. Esztergom, 2006. p. 435. (The Manuscript Maps of Marsigli-Müller with 250 images of manuscript maps on a CD).

4 Danubius Pannonico-Mysicus. Amsterdam and Haag, 1726.

5 Biblioteca Universitaria di Bologna [BUB], Via Zamboni 33 – 35.

Luigi Ferdinando Marsigli (részlet)

THE DANUBE MONOGRAPH

Marsigli, the Conceptual Author of the Mineral Maps

Luigi Ferdinando Marsigli[6] was born in 1658 to a noble family from Bologna, the mater studiorum, the city with the world's first university[7], 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 traveled 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,[8] as well as his book entitled *De Stato Militare*…written about the military machinery of the Turkish state.[9] 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.

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.[10]

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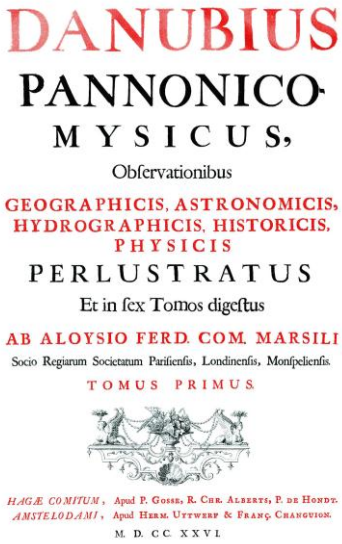
6 In relation to the spelling of Marsigli's name we note that recently his name has been consistently spelled *Marsili* in publications about him. However during the period he worked in Hungary he always signed his name on letters and reports as *Marsigli*. It was later that the version of his name lacking 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 that was from a different branch of the family… Therefore accordingly it is correctly spelled *Marsigli.*

7 Founded in 1087. Its cultural and educational influence spread over all of Europe. Following its example universities were established one after another 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.

8 Allgemeiner Discurs über den Traffico. Vienna ÖStA HKR 1701 BLG July/42. Relation 10. appendix.

9 De stato militare dell'Imperio ottomano, incremento e decremento del medesimo. Hage et Amsterdam, 1732.

10 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 on site negotiations. The leader of the Austrian border demarcation committee was Marsigli. In the spring of 1702 Marsigli was ordered to the western front. He also made it as far as Nürnberg accompanied by Müller, where he was the guest of Eimmart, the


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. C C. X X V I.

The title page of the Danube monograph

The *Danubius Pannonico-Mysicus* is often called the Danube Monograph for short, or even the Anatomy of the Danube.[11] 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 have survived as legacies.

It was published in two versions: in 6 volumes and 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*

same Eimmart who accepted the task of engraving the illustrations of the *Danubius*. He rented a room there 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 favor due to the surrender of Breisach Castle. He then went to France, and departed from Müller's life for good.

[11] The Hungarian and Serbian stretch of the Danube described from geographic, astronomic, hydrographic, historic and physical observations. *Organized in six volumes [and edited] by count Luigi Ferdinando Marsili, member of the Royal Societies of Paris, London and Montpeliere.*

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. Leafing through the book we can share his conviction: Marsigli really explored everything that he could and put it into words and pictures of artistic value.

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 as 330 drawings of the minerals discussed and 33 site plans.

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 these 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.

Native gold from the mine

THE VOLUME ON THE MINERALS

Colleagues

Samuel *Rohfrey* (Samuel Rohfrey in Kreisbach) from Gyulafehérvár (Alba Iulia, Romania) sent him descriptions of the minerals and the mining districts of Transylvania.[12] He answered 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 to 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*.[13]

The letter from Ander Jacob *Schmidt*, a mining supervisor, also deals with mines. He sent a

[12] BUB Vol. 80. C. p. 70. Samuel Rohfrey; Gyulafehérvár (Alba Iulia), February 5, 1701. In Latin.
[13] DPM Vol. I. Pars III.

sketch drawing 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).[14]

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).[15] The drawings are in color 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* from Bologna, was given the most important task of all the Italian masters concerning the preparation of the *Danubius Pannonico-Mysicus*.[16] Both Eimmart and Müller mention in their letters that the *Minerals* volume was engraved in Italy. They however did not state the name of the engraver. We learned from Lelio Trionfetti that having seen the engravings, Müller expressed his great admiration for *Maria Franca*'s art, although he did not know him.[17] Another document mentions that Marsigli paid 100 liras to *Franza* (sic!).[18] A three volume collection of engravings is kept in the Bibliotheca Univesitaria in Bologna, composed by *Francia* himself from his *oeuvre*.

Scattered in the free spaces of these volumes, Francia inserted some illustrations from the *Danubius*, verifying the evidence in the above argument.[19]

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 he had received.[20]

In relation to the maps, Marsigli's most significant colleague was Johann Christoph Müller[21], 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 center of all of Central Europe.

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[14] BUB Mss di Marsigli Vol. 25.

[15] BUB Mss di Marsigli Vol. 11.

[16] Francia Francesco D. Maria (Bologna, October 17, 1657 – January 31, 1735) As a copperplate engraver he worked with G.M. Mitelivel and Lodovico Mattiolival. As an illustrator of books he drew many frontispieces. Bologna, Bibl. Univ. A.V.Tab. III. E.I.2. Vol. I–III. The individual engravings do not follow a strict chronological order, and his illustrations made for Marsigli's book are also distributed throughout the chapters. In volume I he drew Roman coins, initials and minerals.

[17] BUB Mss di Marsigli Vol. 82. p. 27. Lelio Trionfetti; Bologna, January 23, 1703, in Italian. "Inviai a Vestra Ecc. in una mia fino delli 24. ottb. /comsegnava al S. Simiani/ una mostra del primo Intaglio de minerali fatto dal S. Francia e spettante al di Lei Tomo, quale Intaglio per esser il primo /non avendo esso - Francia - per l addietro mai intagliato cose simili/ non penso debba apparire il migliore fra gli altri che non faccendo come appunti questi altri, che qui annessi si trasmettono potra farne il confronto..."

[18] BUB Mss di Marsigli Vol. 82. p. 51. "Contos Netto Della distribuzione delle due milla lire ultimamente spedite per cambio da S. Eccelenza Al Franza a conto 100".

[19] Francia Intaglj. Vol. I–III. BUB Mss di Marsigli A. v. Tab. III. E. I.2.

[20] BUB Mss di Marsigli Vol. 82. p. 129. Lelio Trionfetti; Bologna, 19. April 1703. In Italian.

[21] Johann Christoph Müller, 1673 Wehrd (Wöhrd) – 1721 Vienna

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…"[22] In 1692 in Nuremburg, under the guidance of Georg Christoph Eimmart,[23] he acquired in depth knowledge in the arts of mathematics, astronomy **and** drawing.24 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.[25] 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 he 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.[26]

22 Doppelmayr, Johann Gabriel: H… …hematicis und Künstlern. Nürnberg, In Verlegung Peter C…

23 G. C. Eimmart, der Jüngere (163… …nnen, Malen, Emaillieren, auch im Kupferstechen und Radieren tre… …athematiker und Astronom. Seine Meister waren der Vater und Jac… Durch allerhand feine Kupferstiche, dann auch durch viele nette Zeichnungen und Risse hatte er sich rühmlich gemacht. Von 1674 bis zu seinem Tode war er der stellvertretende Direktor der Nürnberger Maler-Akademie. Er beteiligte sich an der Verzierung der Werke von Sandrart, später wurde er mit der Anfertigung des Kupferstiches vom Einmarsch des schwedischen Königs, Karl ders XI. in Stockholm beauftragt. Als Anerkennung für seine Arbeit hätte es der König gerne gesehen, wenn sich Eimmart in Stockholm niedergelassen hätte, dieser nahm aber das Angebot nicht an.

24 Joh. Gabr. Doppelmayr: Historische Nachricht von den Nürnbergischen Mathematicis und Künstlern. Nürnberg, In Verlegung Peter Conrad Monaths, 1730.

25 1683 – 1699.

26 In the spring of 1702 he left Hungary and worked for a year in Nuremburg. Not long after Marsigli had fallen out of favor (1704), we find Müller in Vienna, where he received the commission to survey the Hereditary Lands, which he fulfilled with great diligence and thoroughness.

Sand in the Bed of the Danube and Tisza

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.

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 Hungary. He was lucky to be provided with an exceptional opportunity to get acquainted with the underground 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 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 be seen even 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*.

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 into the depths of the earth with his consent, 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,[27] he also received all the information he was interested in – 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.

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).

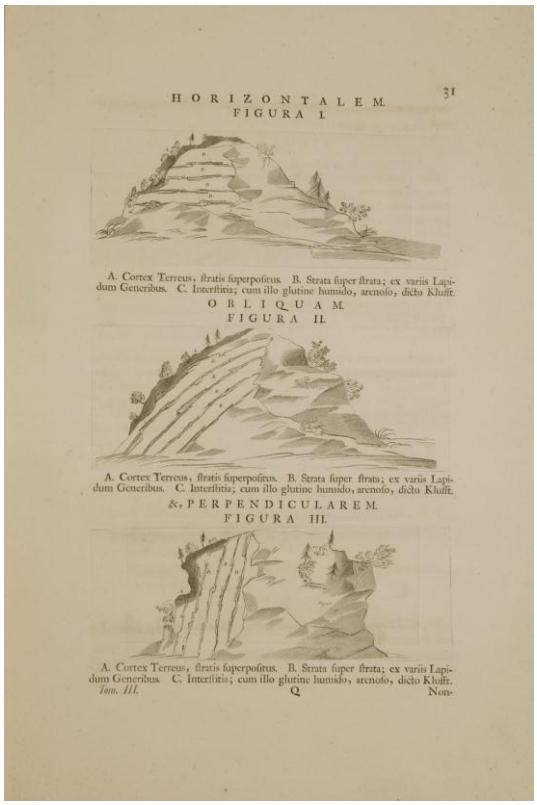
Not genuine rocks: In his description of *rock salt, petrified bodies and mineral salts* he primarily dealt with Transylvanian salt mines, and spent an astonishingly long time with them. The rock salt hills, such as the one that can be seen at Sófalu and the springs welling up from these hills intrigued 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 included 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.

[27] Dipartimento di Archeologia, Universta di Bologna, piazza S. Giovanni in Monte 2.



The inner structure of the mountains

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 only the circumstances which followed determined which ones they developed into. He tried to support his 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 II 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.

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 border 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.

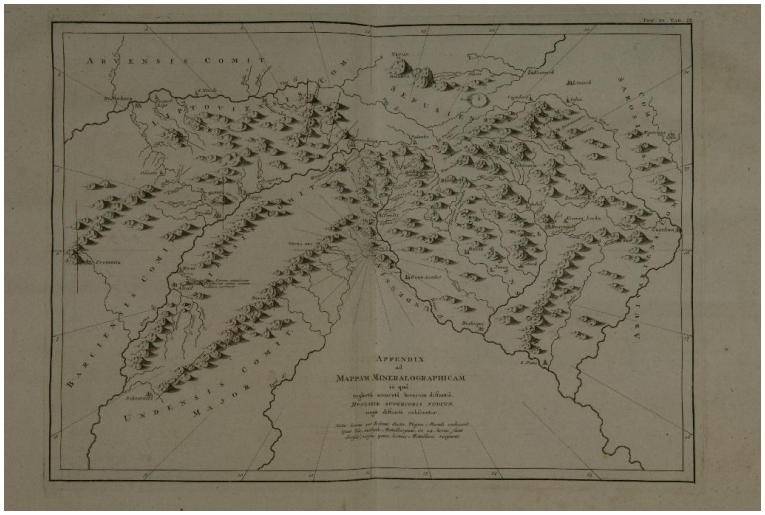
The summary map of minerals

A summary map of minerals begins the description of the *rocks and ores found in the mines.*[28] 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

[28] Müller's drawing; measurements: 45.5 × 67 cm.

beside them indicates whether it is a gold, silver, copper, iron, salt, mercury or lead mine.

[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[29], introducing 14 types of mines: gold, silver, copper, iron ore, salt, garnet, mercury, lead, cinnabar, magnetite, antimony and opal mines.]



Appendix to the map of minerals

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.

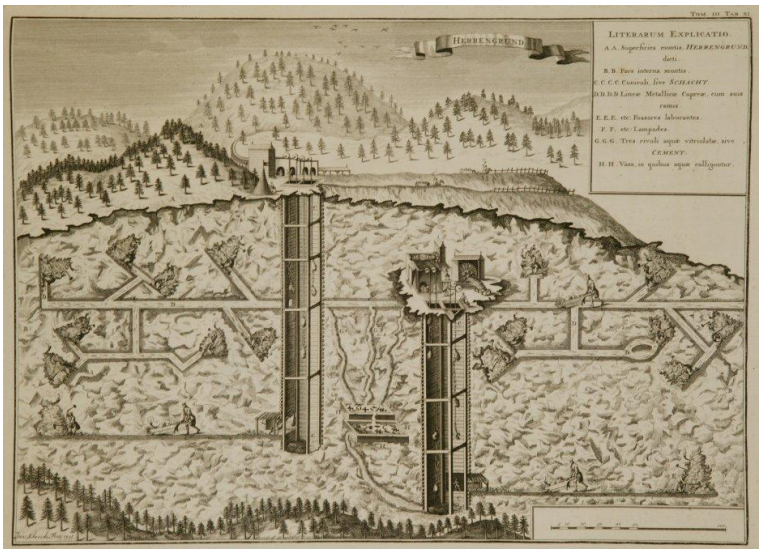
[29] Marsigli borrowed the symbols for the individual minerals from alchemy.

[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.

Note: The straight lines running through the mines show the cardinal directions (which here we have divided into 24 hours 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.



The mine Herrengrund nearby Selmec

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 funneled 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

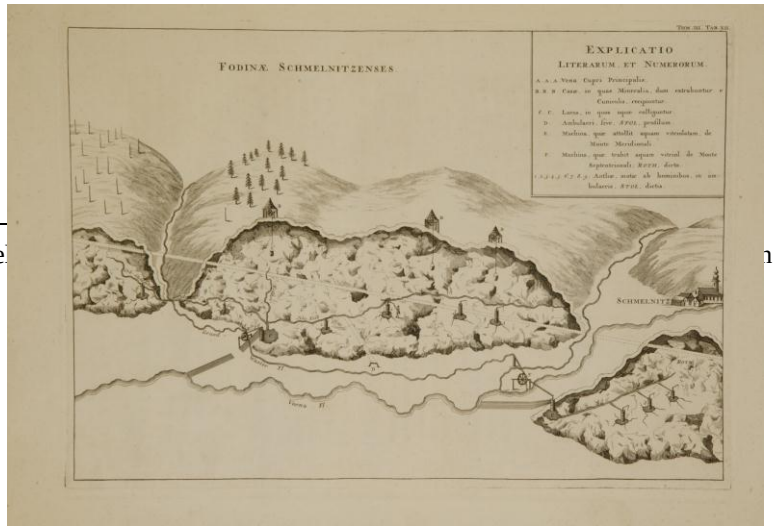
F.F. etc: Torches

G.G.G. etc: Three streams of sulphurous water.

H.H. Pool in which the waters are collected.

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. Because of water they had to spend great sums of money on machines and horses, because 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.[30] 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.



[30] For example, Sámuel [illegible] n of the steam engine in mines.

The mines of Selmec

[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.

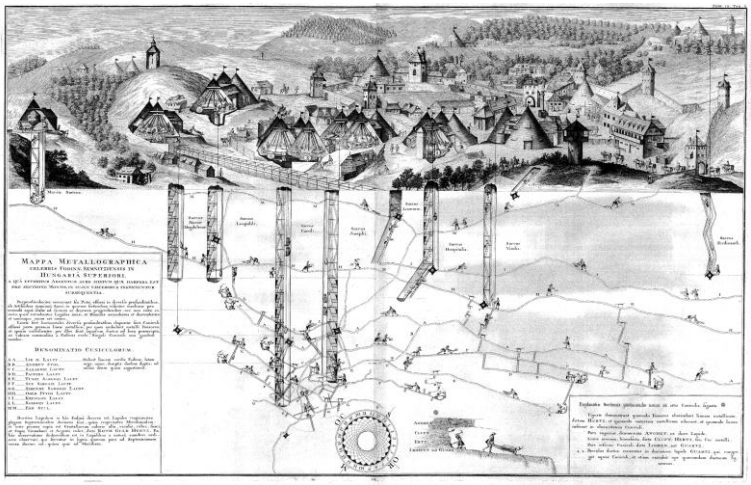
It is the last of these site plans I have shown that is linked to my not exactly colossal discovery.

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*[31] reveals that Marsigli was awed by the view of what was the most famous mine in Europe according to him. In the drawing he shows all the operations carried out as the veins of ore were followed

[31] DPM Vol. III. p. 22. 45.5 cm × 70.5 cm

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*.



Map of the famous ore mine in Selmec in Northern Hungary

[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.

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 vanquish the dark of the gallery with 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 Selmecbánya (Banská Štiavnica) gave me 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 drew up 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[32].

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 true about the volume of this work dealing with minerals as well. 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 he based these. We suspect that Müller gave these their final form, just as with the site plans and maps. The fact that gives us 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 his artistic skill. As has been mentioned, the final framing of the maps must be clearly attributed to Müller, but we do not have definite knowledge about who made the copperplate engravings of those. 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 the

[32] Banská Štiavnica. Státny Ústredny, Bánsky Archív (SK)

whole work – were given their final forms in his workshop.

In conclusion we consider it proper to commend Marsigli's brilliance as a scholar with a few words. If someone just pages through the six volumes of the Danubius, they will ask the following question with fascination: How was a soldier who from spring to fall played an outstandingly important role in the 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 – he maintained contacts with nearly every significant scholar in Europe. On a scientific level the Danube Monograph even today serves 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 mine maps". However, similar worth is represented by the maps indicating Roman antiquities[33], and the first thematic commercial map surviving in the manuscript, which outlines the commercial possibilities of Hungary following the Turkish wars.[34] 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.*

[33] Danubius Pannonico-Mysicus Tom. II.

[34] *Mappa Geographica facta in usum commerciorum, a Buda et Baja, tanquam centris, et terminis a quo, tam cum Polonia et Italia, quam praecipue, cum Imperio Ottomanico, per vias, punctis rubris heic expressas, instituendorum: et Scripturae, huc spectanti, clarius lumen praebens.Notandum: pauca illas lineolas nigras (- - - -) denotare Aggeres, aquam impedientes".* 50.5 × 75 cm; 1699; Vienna; Staatsarchiv, Kartensammlung HRK 1701 BLG Juli/42. Relation 10. Beilage; Published by Antal András Deák: Maps from under the Shadow of the crescent Moon.