

# Geological and mining heritage : Croatian historical mining sites : [poster]

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# GEOLOGICAL AND MINING HERITAGE

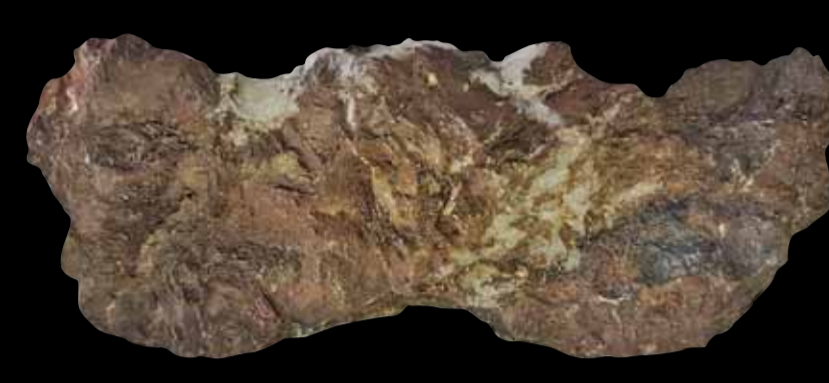
## Croatian historical mining sites



### GVOZDANSKO



**Ore:**  
limonite and siderite with sulphide phenomena (galenite, pyrite, chalcopyrite, chalcocite, tetrahedrite and bornite)



**Metals:** Ag, Pb, Cu, Fe

--- Mining takes place as early as Roman and Illyrian times (Fe)

--- 1347 Zrin was awarded to family of Bribir counts who established Zrinski family



Coat of arms of Zrinski family



Nikola III Zrinski



Nikola IV Zrinski

--- 3. 3. 1463 Petar Zrinski was allowed to mine metals by the King Matthias Corvin (Pb, Ag)



--- 1488 the fortress of Gvozdansko was built

1524 a mint workshop started to emit silver coins



Silver coins from Gvozdansko - talies (Archaeological museum in Zagreb, replicas inv. E21714, Photo: Igor Krajačar)

--- 1530 the mint and mines were leased to Leonard Gruber Samoborski and Mark Stettner Ljubljanski

--- 13. 1. 1578 the Gvozdansko fortress fell under the onslaught of the Ottoman Empire



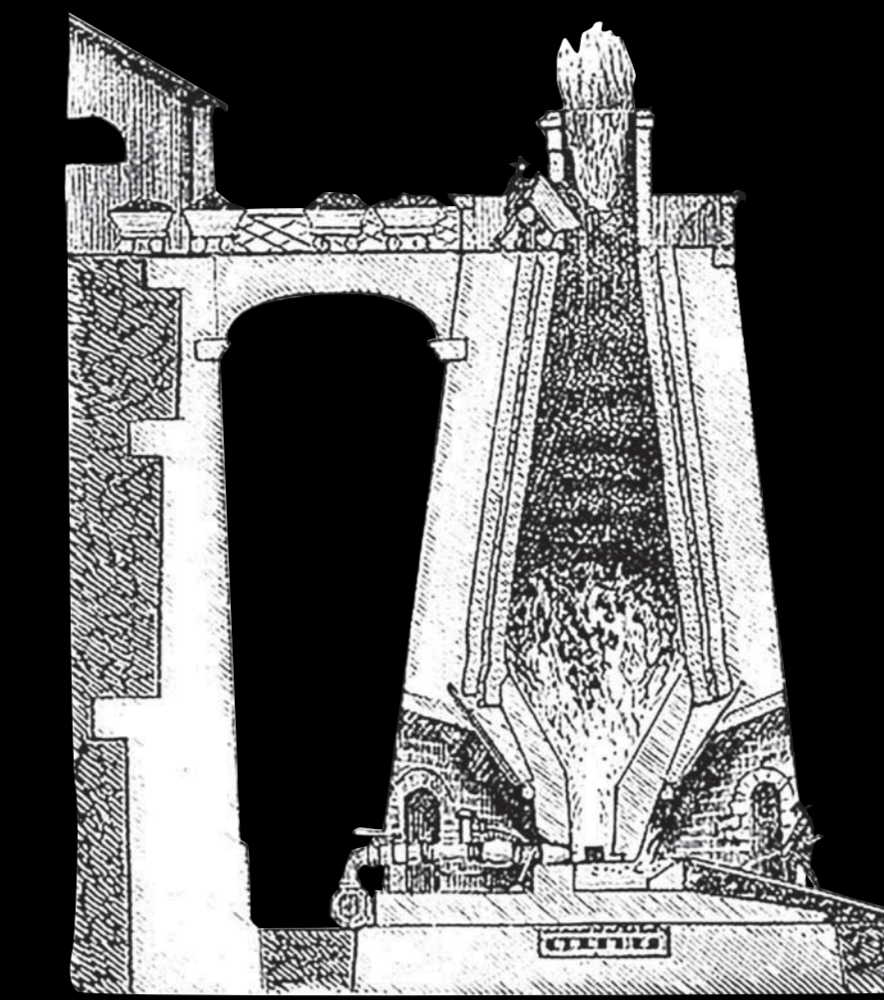
Ferhad Pasha Sokolović

...and then **Ferhad-Pasha** changed tactics and decided on a night-time attack...just as the onslaught was about to begin, all the torches went out. Fearing the possible trap, he aborted the attack until the next morning. On Monday, the **13th of January 1578**, everything was still. When they entered the main yard, they saw dead bodies of defenders. The harrowing sight impacted Ferhad-Pasha so greatly that he allowed the burial of the dead according to Christian customs..."

(Kekez: Pad Gvozdanskog 1578. g.)

--- 1707 mining was revived (Ag and Cu), later on the "August mine" was opened in the Gradski potok and it was the largest copper mine in Austrian-Hungarian Empire

--- 1726 the Imperial Mining Office was located here

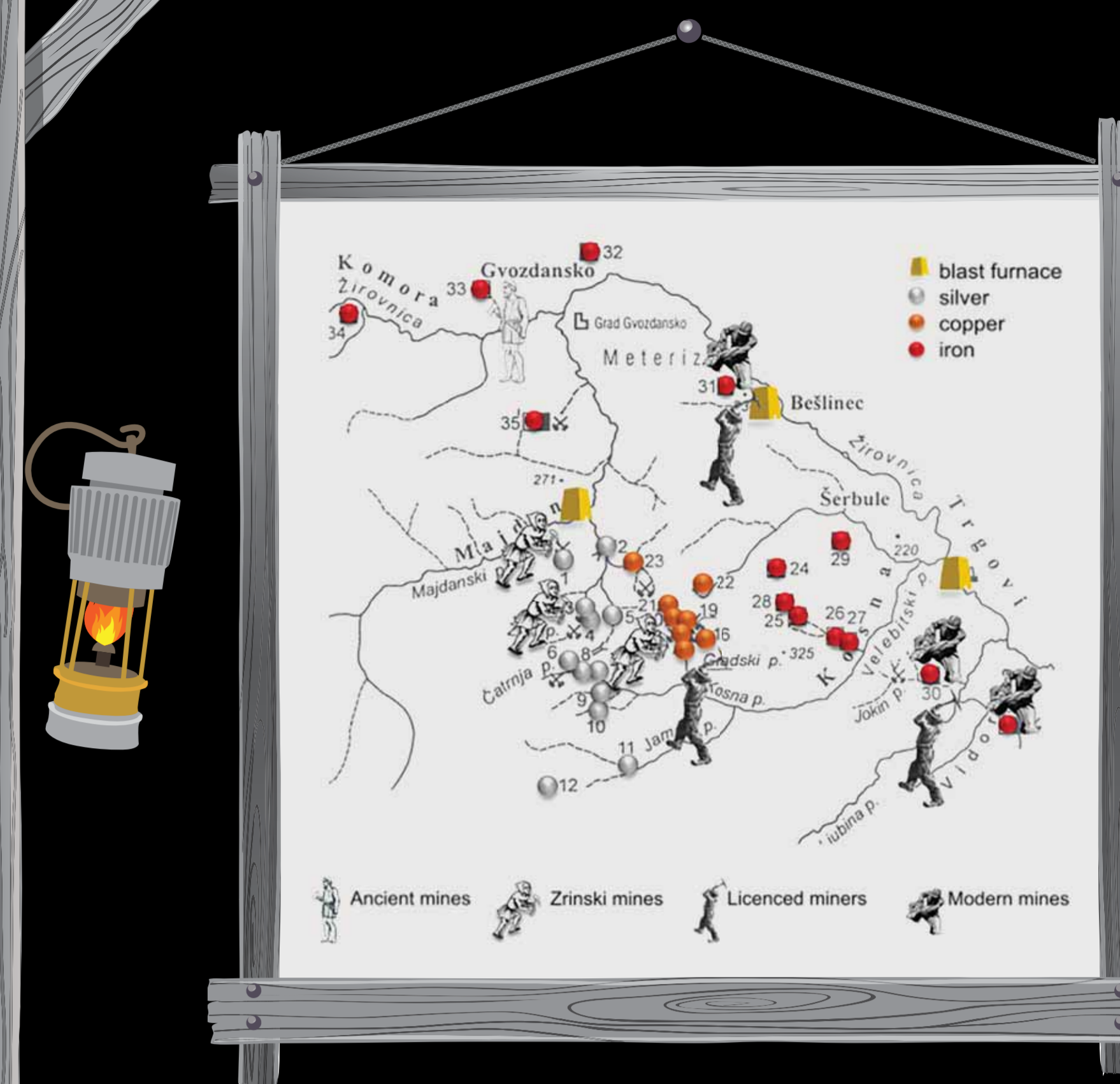


Household Cyclopedia 1906



The Bešlinac blast furnace - the state of art of its time

--- 1795 iron production started, processing was carried out on site using blast furnaces in Trgovi and Bešlinac.

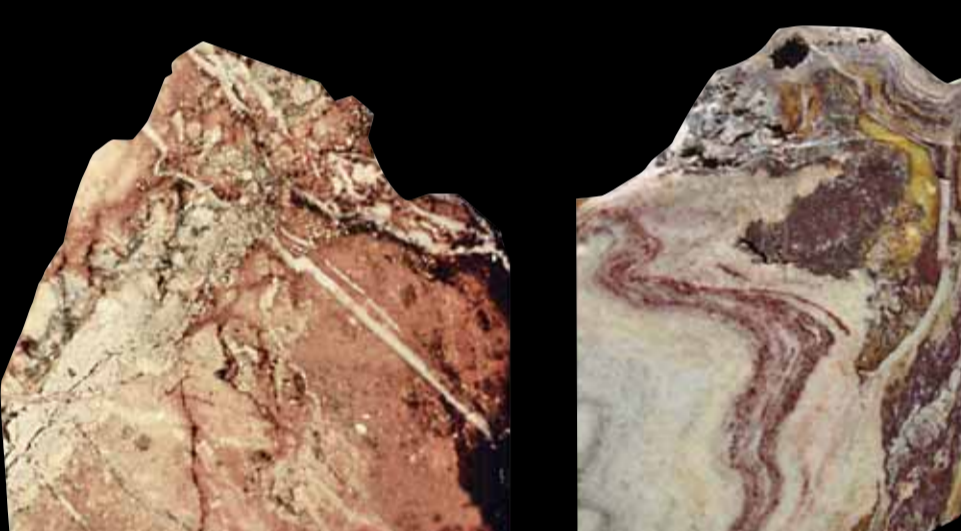


--- 1966 the last mine was closed

### RUDE



**Ore:**  
hematite, siderite, chalcopyrite  
**Industrial mineral:** gypsum



**Metals:** Cu, Fe

--- It is assumed that the mine existed in Roman times



Queen and Empress **Barbara Celjska** (1381-1451), "The Black Queen", the second wife of the Croatian-Hungarian King Sigismund of Luxembourg, practiced alchemy in the basements of her castle in Samobor. She allegedly produced silver and then gold by transmutation of copper from her mines in Rude.

--- 1481 first record of Copper mining

--- 1530 Leonard Gruber Samoborski mined copper here, and operated in Gvozdansko as well

--- 1582 Ungnad opened a new shaft, two additional furnaces, two copper forges and employed about 200 people, mostly Germans

--- 1591 the first known miners' strike in Croatian countries broke out here

--- 1587 the Erdödy family possessed the mine

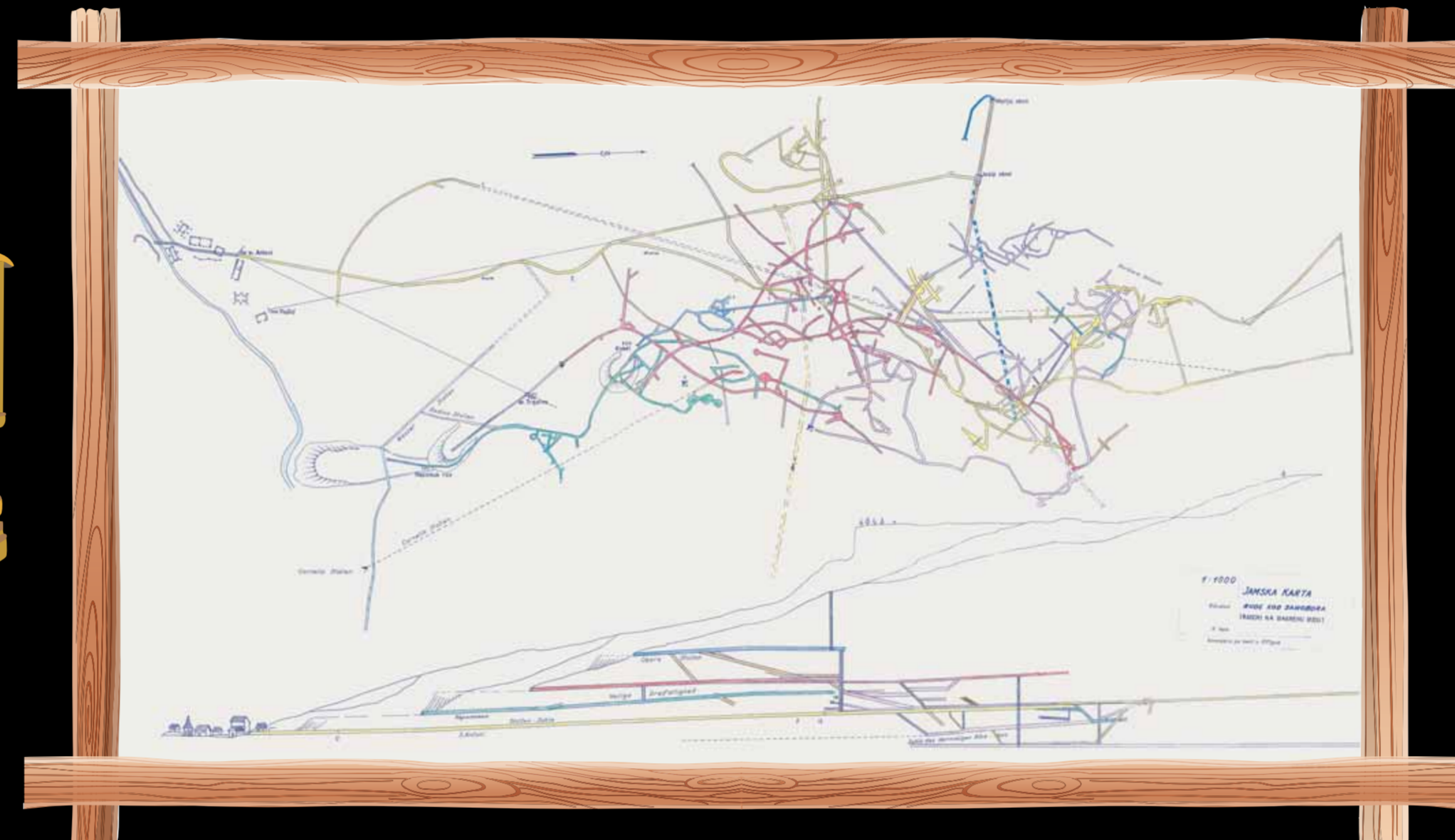
--- 1653 the mine was taken over by the Auersperger family

--- 1698 Croatian nobles and Milan Androk established a Mining Society that managed the mines

--- 1714 the Auersperger family owned the mine once more

--- 1763 the Erdödy family continued to operate the mine

--- 1777 a precise tunnel map, still credible and unique, was drawn



--- 1785 first description of Rude mine by **Andrija Pribila** was published

--- 1788 Samobor was the seat of the Mining Substitution Court, a branch of the Mining District Court of Schemnitz (today Banská Štiavnica), run by a mining master (Bergmeister)

--- 1851 the copper ceases to be mined; iron ore and gypsum were excavated

A legend has it that the first miners were the Dwarves - Bergmans a small bearded man dressed in green with yellow skin and snake eyes. They were last seen in the late 19th century digging for gold and other valuable metals.



--- 1952 - 1956 last research was conducted reporting the copper and iron ore quantities not feasible

--- 2002 recovery of two artificially connected shafts **Sveto Trojstvo** and **Kokel** after the initiative from **prof. dr. sc. Boris Šinkovec**, the **KUD Oštrc** and locals



Old town Samobor



**Greblica** or **Miner's cake**, was often the only meal of the miners, a salty thin cake with cheese and walnuts or cheese and green leafy vegetables. Named after a tool for cleaning ashes in old stone ovens.

About 350 meters long shafts are open to visitors as a mining museum in nature.



Photos: R. Ibršević

One of the oldest European copper and iron ore mines. During the 16th century the copper production was twice the size of the total copper production in England and four times the total production in Norway, and it reached one third of the total production of the famous Swedish mine in Falun.

### SOVINJAK



**Industrial mineral:**  
pyritic bauxite



**Product:**  
alum, green vitriol, sulfuric acid, Prussian blue, "terra rosa per pittori"

--- around 1566 first mining operation started

--- 1646 first notes on history of vitriol extraction underneath the Sovinjak

--- 1780 Pietro Turini found and described the ore as a Pyrite Aluminoso-Vetriolica and Giovanni Arduino, professor of mineralogy, chemistry and metallurgy, performed first analysis

--- 1781 in Koper Turini applied the extraction process proposed by Arduino

--- 1784 mine Minjera and a factory of alum in Sovinjak was opened, the labor force was imported



In 1791 (30 years before Berthier's analysis of bauxite from Les Beaux) Sovinjak's bauxite is analyzed qualitatively and quantitatively by professor **Arduino**.

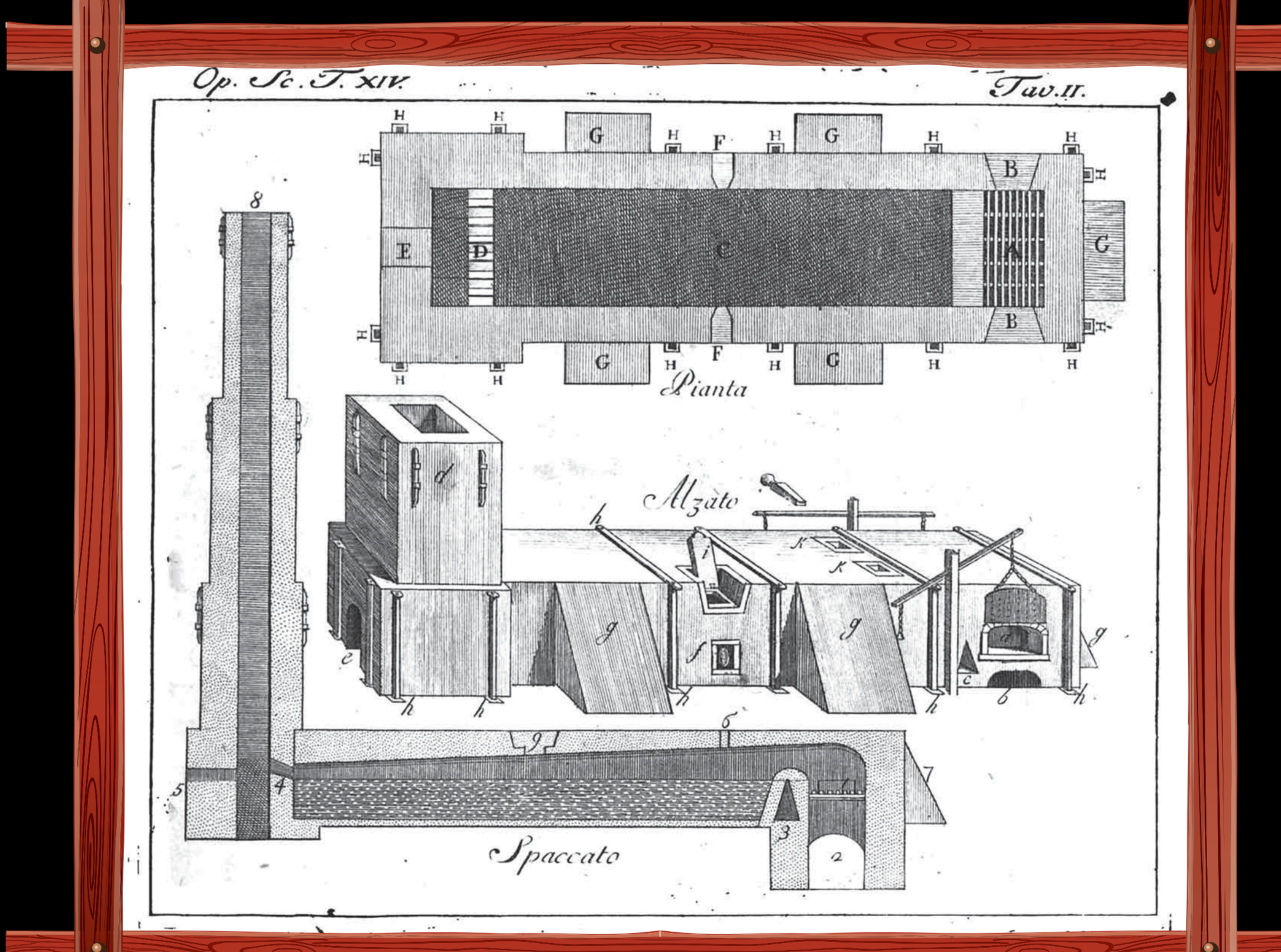
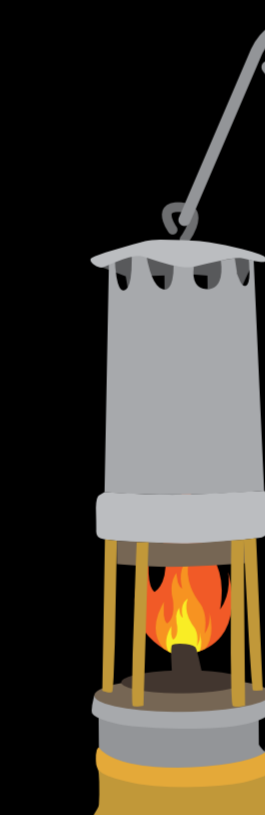
--- 1797 Istria joined the Austro-Hungarian Empire, export-import operations were obstructed and Minjera was cut-off of several vital privileges



Excavation was performed by underground mining, shafts still carries the traces of blasting.



Workers were equipped by density-meters (Beaume's scale) and used them for quality control of the processed solutions.



**Turini 1782** encouraged professor **Arduino** to find alternative for lead cauldrons used during alum precipitation. In 1790 *forno a riverbero* an "horizontal furnace" was designed and built in Sovinjak. Results were excellent, the consumption of firewood considerably lowered and the purity of alum improved. Based on these results *Eccellentissimi Deputati Alle Miniere* prohibited the use of cauldrons.

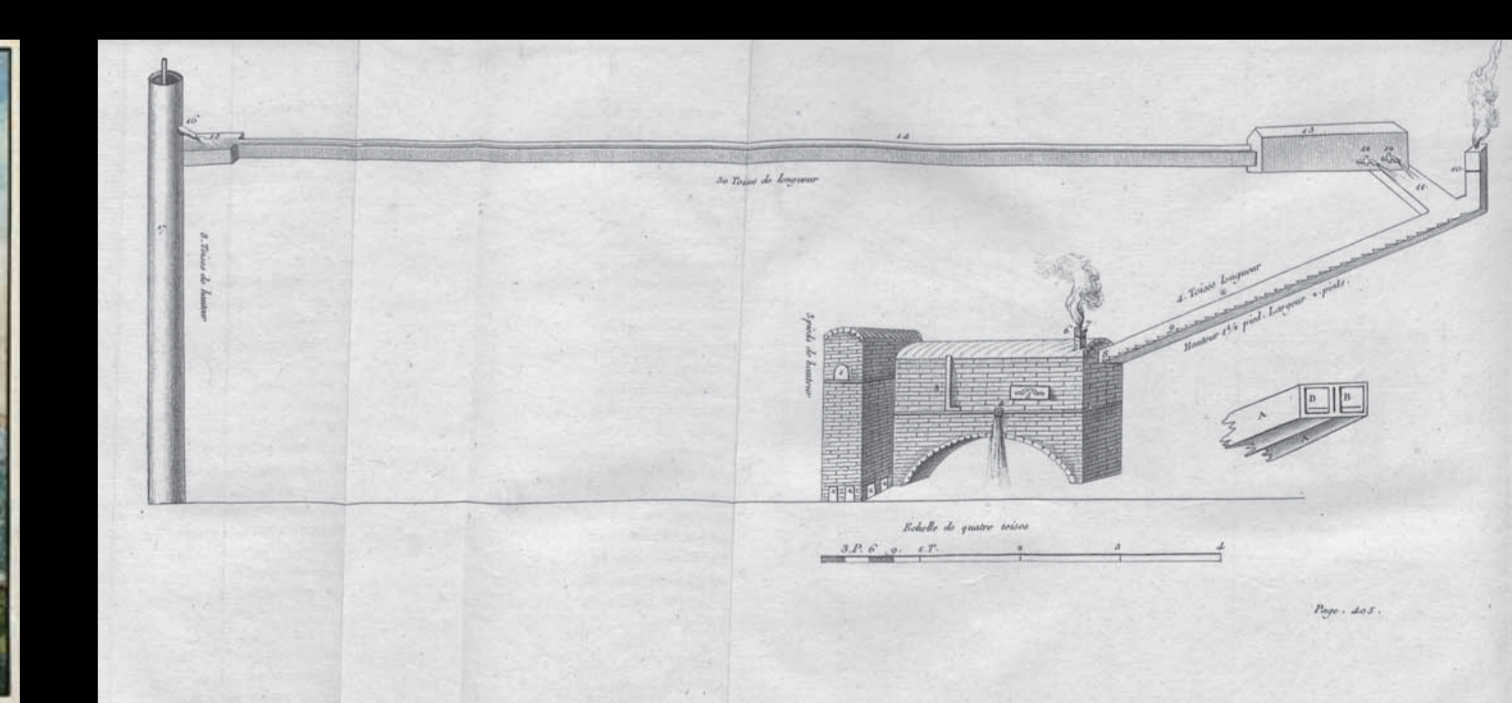
--- 1801 **Giuseppe Maria Socquet** wrote *Sur l'alunierie d'Alun natuel de Souvignaco en Istria, province ex-Veneto, et sur les procedes particuliers employes pour son et extraction et sa purification* describing in detail the production in Minjera

--- 1808 **Pietro Turini** published his memoirs *Della preparazione dell'allume nella Miniera di San Pietro nel diartimeno dell'Istria* recognized as the first elaborative work on bauxite processing

--- 1823 Minjera declared bankruptcy and in 1863, after a robbery and murder of the factory director Antonio Deperis, the factory was closed



In the most successful times, factory employed about 70 workers (40 miners) and used the services of 350 carriers.



Factory used a unique mechanism for pumping the liquid discharge from leaching which was described by Socquet as an ingenious and innovative process.

### RADOBOJ



**Industrial mineral:**  
sulphur in marl



**Product:** sulphur



In 1811, a farmer named **Ambrose** was digging a basement for his vineyard cottage. He started a fire in the pit to burn some branches. To his own surprise, he noticed that not only the trees were burning, but the ground was burning as well. So he brought a chunk of the earth to a priest. Unfortunately, his discovery resulted in the confiscation of his land.

--- 1805 Waldstein-Kitaibel's first notes on sulfur in Zagorije

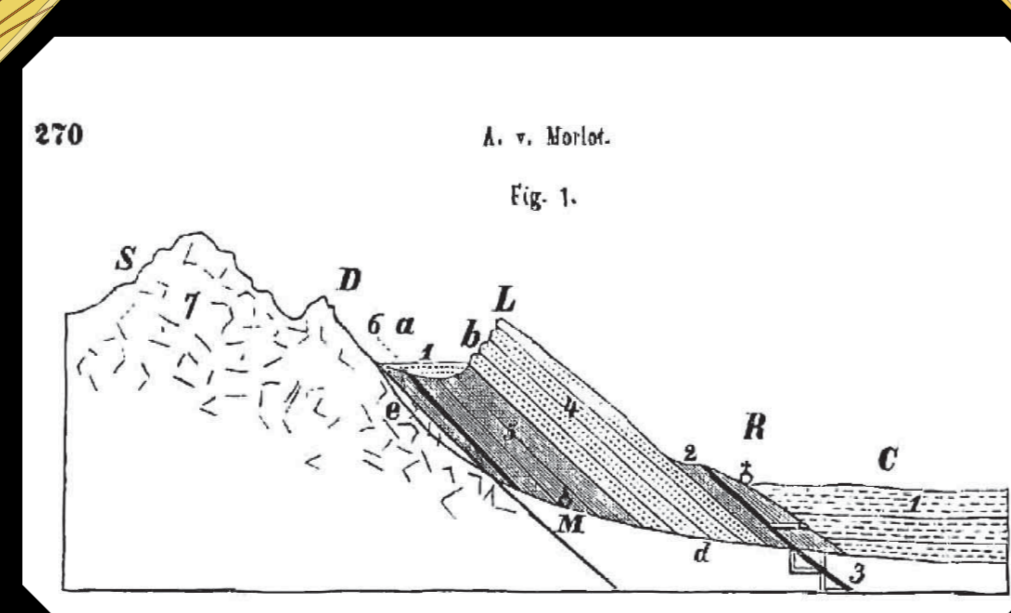
--- 1811 Imperial mine of sulfur was opened

--- 1816 the Mining Substitution Court was transferred here from Rude due to the war

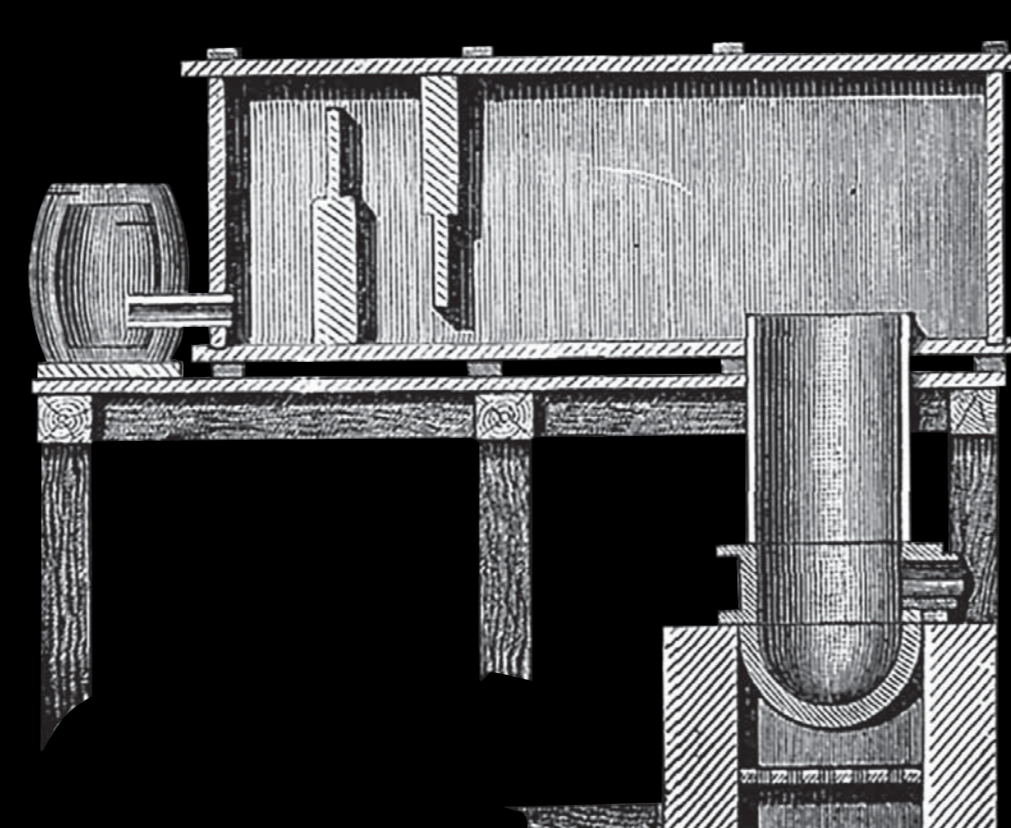
--- 1833 primary school in Radoboj was established by miners

--- 1865 mine was sold to Sonnenberg, Pulzer and Moses

--- 1917 sulfur extraction was stopped



Geological profile after Morlot (1850)



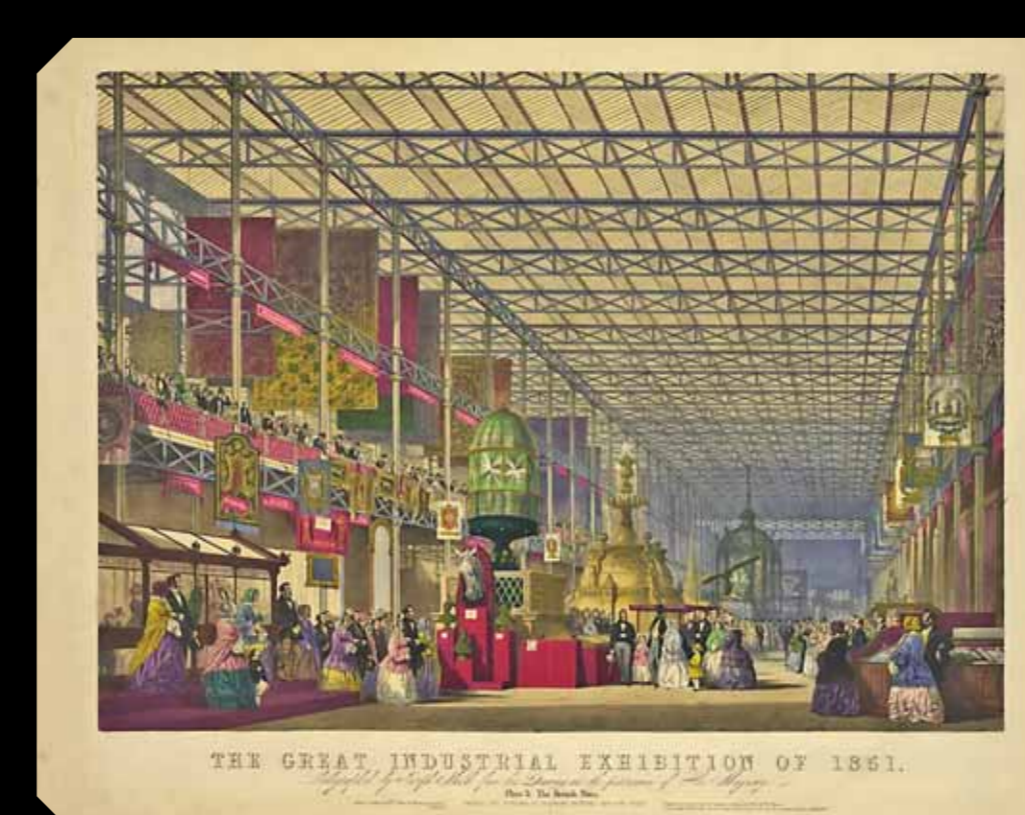
A **Radoboj machine** was a device based on sublimation designed and constructed for cleaning sulfur from marl. (Kispačić, 1880.)



**Friedrich August II, King of Saxony** (1797-1854) paid great attention to the natural Sciences. During his trips he often disguised himself not to be recognized. In 1845, he visited Radoboj, where he took a sample of sulfur for his private collection.



(Min 20650 Sy, Senckenberg Naturhistorische Sammlungen, Museum für Mineralogie und Geologie, Photo: Jana Wazecik)

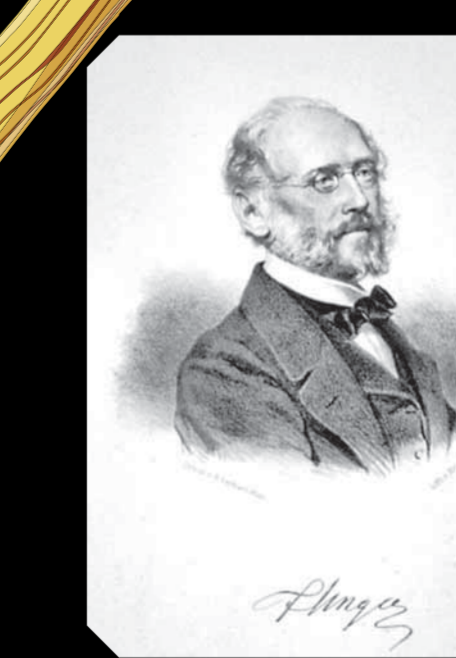


The Great Exhibition of the Works of Industry of All Nations in 1851

Sulfur from Radoboj has been exhibited at major exhibitions, in 1851 in London at the Great Exhibition of Works of Industry of All Nations and in 1864 in Zagreb at the First Dalmatian-Croatian-Slavonian economic exhibition where it was awarded a silver medal.



Silver medal from 1864



**Franz Unger** (1800-1870) -Austrian palaeobotanist -studied Radoboj fossilised flora for 30 years -published „Die fossile flora von Radoboj“ in 1869.



The oldest fossil of vine leaf in Europe has been found in Radoboj together with other fossils of plants, insects, fish and shellfish. (Croatian Natural History Museum)



*Flabellaria maxima* UNGER

(Universalmuseum Joanneum, Geology & Palaeontology, Graz, Austria)



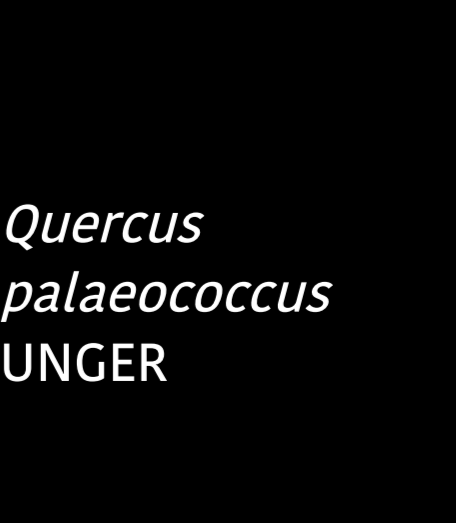
**Oswald Heer** (1809-1883) -Swiss paleobotanist and entomologist -studied fossilised insects of Radoboj -published series of books "Die Insektenfauna der Tertiärgebilde von Oeningen und von Radoboj in Croatien" (1847, 1849, 1853 and 1867).



*Lithemis lejeuneacarpentieri* FRASER (University Liège collection)



*Bibio giganteus* UNGER (Croatian Natural History Museum)



*Quercus palaeococcus* UNGER



*Cystoseirites communis* UNGER