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*Source / Izvornik:* **Building connections for global geoconservation : abstract book, 2021, 261 - 262**

**Conference paper / Rad u zborniku**

*Publication status / Verzija rada:* **Published version / Objavljena verzija rada (izdavačev PDF)**

*Permanent link / Trajna poveznica:* <https://urn.nsk.hr/urn:nbn:hr:169:123989>

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*Download date / Datum preuzimanja:* **2024-07-15**



*Repository / Repozitorij:*

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## **Interconnection between cultural and geological heritage at four Croatian historic mining sites**

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**Keywords:** geological heritage, Radoboj, Rude, Sovinjak, Trgovska gora

### **Introduction**

Historic mining sites represent a mining heritage that can be classified as a subset of industrial heritage, as well as historical heritage. Thus, they are a part of cultural heritage. On the other hand, they are interconnected with geodiversity. Although mining activities have negative impacts on geodiversity, they also bring to light inaccessible earth materials, geological forms and traces of geological processes. Consequently, historic mining sites are valuable places for geotourism and should be protected not only as cultural heritage but also as geological heritage. This presentation considers four existing/potential mine heritage sites in Croatia (Radoboj, Rude, Sovinjak and Trgovska gora), which are valuable both as cultural and geological heritage and discusses the exigency for their appropriate geoconservation.

### **Case studies**

#### **Radoboj**

The sulfur mine in Radoboj, which was active in the 19th century, is no longer available for restoration. Nevertheless, thanks to the local community, the Radboa Museum was opened four years ago, presenting a rich geological, archeological and mining heritage. The world famous Radoboj machine, invented to purify sulfur, is the most important cultural heritage associated with mining, preserved only as a scheme and description in an old mineralogical textbook. Due to sulfur mining, a large amount of fossilized flora and fauna of the middle Miocene was found and attracted many famous paleontologists who collected specimens that are now found in many European natural history museums. Collections of fossilized insects are world famous. These specimens have educational, as well as scientific value in the field of paleontology and paleoecology. Neither the mining- nor geological heritage of Radoboj are officially protected.

#### **Rude**

The copper and iron mine in Rude has a long history from the Middle Ages (probably even from Roman times) to the 20th century. It was located on the copper route and its "golden times" were in the 16th century. Recently, local community made great efforts and opened a part of the mine for visitors. Now the mine is even officially protected as cultural heritage site. As Croatia is not rich in ore deposits, the example of Permian siderite-polysulfide-baryte mineralization formed during rifting along the passive Gondwana margin visible in the mine has a great value for education in the field of economic geology. Therefore, it would be important to protect this deposit as geological heritage site as well.

#### **Sovinjak**

The pyritized bauxite mine Minjera near Sovinjak is the first bauxite mine in the world. The grey bauxite was mined from more than 400 years ago to the second half of the 19th century. Sulfuric acid, alum, vitriol and Berlin blue were obtained from pyritized bauxite. Descriptions and schemes of the then very modern and advanced factory are a valuable mining heritage. The geological significance lies in the fact that bauxite from the Minjera mine was first mined, analysed (in 1780) and described in the scientific articles (1808). All of these had happened before bauxite from Le Baux was described. Unfortunately, due to unsettled ownership, the Minjera mine did not receive adequate protection for the site of such importance, neither cultural, nor geological.

### **Trgovska gora**

Mining in Trgovska gora dates even back to ancient times. Intensive mining of silver, copper and other metals was introduced by the noble family Zrinski in the Middle Ages during the constant threat of Ottoman Empire. Mining, metallurgy and minting in this area are an important historical heritage. Today, only the fortress and a blast furnace remain and represent an already protected cultural heritage. In the area of Trgovska gora, within the ore-bearing area (16 km long and 7 km wide), several mineralization zones can be distinguished: (1) iron-rich zone with quartz-siderite veins and metasomatic ankerite; (2) copper-rich zone with quartz-siderite-chalcopyrite veins; (3) lead-rich zone with quartz-siderite veins containing galena and sphalerite; (4) siderite zone with sulfides and sulfosalts of copper, lead, cobalt and nickel; (5) barite zone. Thanks to the work in the “MineHeritage” project, the Ministry of Economy and Sustainable Development recognized the importance of Trgovska gora as geological heritage and proposed to extend the boundaries of the future Zrinska gora Regional Park to include the area of the historical mines of Trgovska gora.

### **Conclusion**

The preservation of geological heritage within the mining heritage context in Croatia is fundamental to promote proper protection, valorization and use as geotourism destinations. The four presented historical mining sites are examples of possible geotourism destinations with high potential. Tourism is an important economic sector in Croatia, therefore additional geotourism destinations would contribute to the diversity of the tourism offer. In addition, these sites have a great educational significance for Croatian students as they represent geological phenomena that are not widespread in Croatia.

### **Acknowledgments**

This contribution is supported by the project “MineHeritage: Historical Mining – Tracing and Learning from Ancient Materials and Mining Technology” funded by the European Institute of Innovation and Technology (EIT), a body of European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation.