16th INTERNATIONAL CONGRESS OF SPELEOLOGY

Proceedings

VOLUME 2




Edited by
Michal Filippi
Pavel Bosák

16th INTERNATIONAL CONGRESS OF SPELEOLOGY
BRNO 2013 CZECH REPUBLIC
WHERE HISTORY MEETS FUTURE

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Czech Republic, Brno

July 21–28, 2013

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KATALOGIZACE V KNIZE - NÁRODNÍ KNIHOVNA ČR

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Cover photos (some photos were adjusted/cropped)
Top left – A gallery along the "Rio de los Venezuelanos" in the Imawarì Yeuta Cave system in quartz sandstones, Auyan Tepui, Venezuela. Photo V. Crobu. For details see the paper by Sauro et al.
Top right – The 15th siphon of Ramo Nord in the Grotta del Bue Marino, Sardinia. Photo by R. Husák. For details see the paper by D. Hutňan.
Bottom left – Using an Xbox Kinect equipment to survey a cave. Photo by J. Gulley. For details see the paper by Covington et al.
Bottom right – Inclined workings of the Voskresenskyi Mine, Ural Mountains, Russia. Photo by A. Gunko. For details see the paper by A. Gunko.

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The names of the Committee members are given along with their home countries and fields of research they represented as convenors.

Contents

Preface

Dear readers, the Proceedings volumes you are holding in your hands were issued within the 16th International Congress of Speleology (hereafter 16thICS) on July 21–28, 2013 in Brno, Czech Republic. Let us welcome you to its reading.
In total, over 320 contributions (over 250 oral presentations and over 70 posters) by more than 750 authors have been received to be included within the Congress Proceedings. This represents over 2,300 received e-mails and a similar number of responses during the last 6 months, approximately 4,300 electronic files and over 1,450 printed pages of the text. To put it simply, "really, really much interesting stuff concerned with cave and karst subject". The author's guidelines stipulated that the particular contributions should not exceed 6 pages of text and we were delighted to find that most authors prepared contributions close to this upper limit. Only very few contributions did not exceed one page of text. This illustrates a clear willingness of the cavers and karst scientist to share their discoveries and research conclusions.

The presented contributions (abstracts/papers) stand for both oral and poster presentations as indicated in the headings. Contributions in each session are arranged alphabetically by the last name of the first author. All contributions were reviewed from the viewpoint of technical quality and scientific content by members of the scientific committee and invited reviewers. The authors had the opportunity to revise their papers in response to reviewer's comments and we were pleased to see that the reviews have improved the clarity and readability of the contributions. However, profound improvement of the English language could not be arranged due to the shortage of time and insufficient human resources; the authors themselves are therefore responsible for the linguistic level of their contributions.

Thirteen thematically different sessions and six special sessions were scheduled within the call for your contributions to cover the whole range of subjects to be discussed within the wide scope of the 16thICS. The low number of contributions for some of these "detailed" sessions necessitated their merging with others. As a result, eleven original and three joint sessions are presented within the Proceedings. The contributions were grouped into three separate volumes. The purpose of this arrangement was that each particular Volume is filled with a certain logical hierarchy of topics, and that related topics are presented together. It was also the intention that the content of each Volume is topically balanced and contains both generally interesting (popular) topics with rich photographic documentation and hardcore scientific topics dominated by tables and plots.

Volume I starts with three plenary lectures representing three global topics related to 16thICS subject. Further it contains papers concerned with history of research (session "History of Speleology and Karst Research"), archeology and paleontology (sessions "Archaeology and Paleontology in Caves"), topics focused on management and preservation of caves and karst areas and other social-related aspects (sessions "Protection and Management of Karst, Education"; "Karst and Caves: Social Aspects and Other Topics"). In the last mentioned session you can also find a small part devoted to extraterrestrial karst. Volume I is ended by a relatively large portion of biology-oriented papers placed within the session "Biospeleology, Geomicrobiology and Ecology".

Volume II contains the traditionally heavily attended session "Exploration and Cave Techniques" and by the related session "Speleological Research and Activities in Artificial Underground". These exploration topics are, we believe, logically supplemented with contributions from the field of "Karst and Cave Survey, Mapping and Data Processing". The content of the second Volume is completed with a somewhat more specialized session "Modelling in Karst and Cave Environments" and with session "Cave Climate and Paleoclimate Record". The last mentioned session probably better fits to the end of Volume III, but it was placed into Volume II in order to reach balance in the extent of the individual volumes.

Volume III also starts with traditional, heavily attended topics organized in two sessions: "Karst and Caves in Carbonate Rocks, Salt and Cypsum" and "Karst and Caves in Other Rocks, Pseudokarst". These topics are supplemented by the related session "Speleogenesis". This last volume of the Proceedings is ended by the study of cave minerals, included in a specific session "Cave Minerals".

It is clear already from the previous ICS meetings that the range of the published topics becomes wider and wider, including localities in the whole world but also – owing to the access to high-quality spacecraft images – from other planets. The range of the instrumental, analytical and software methods employed in cave and karst research is remarkable and shows that the topic of "cave & karst exploration" attracts an ever increasing number of researchers even from already established scientific disciplines.

Let us also say a few words about the selection of the cover photos for the Proceedings volumes. The idea was to select such photos which would best represent all topics (especially those enjoying the highest interest) in each particular volume and be of high technical quality. Since we believe the cover page is a place for a serious presentation of the inner content, we made our selection from photos used in the presented papers. In one case the additional photo was requested to get a better representation of the topic. For our purpose, we decided to place several photos on the cover page of each volume. We hope that you enjoy them.

We wish to take this opportunity to apologize for the all mistakes which might have possibly originated within the operations with different versions of the manuscripts and other related files and e-mails which passed through our computers. We believe that everybody find their interesting reading in the Proceedings and we wish that the whole publication (Volumes I–III) becomes a valuable record of the 16th meeting of enthusiasts addicted to the fascination of the underground world.

Finally we wish to thank all the authors for their contributions. Enormous thanks belong to the reviewers and especially convenors (members of the scientific committee) of the particular sessions for their time and effort in the improvement of the overall message of the texts. We also wish to thank Michal Molhanec who significantly helped with the on-line form for the contribution submission, to Jiří Adamovič who repeatedly helped us with the improvement of our English, and to Jan Spružina, Zdeněk Motyčka, Jana Holubcová, and Renata Filippi who contributed to the preparation of the Proceedings.

After the few introductory words, let's now enjoy the papers from localities all over the world, presenting all forms of activities in karst, caves and other related surface and subsurface environments!

Michal Filippi and **Pavel Bosák**
Proceedings editors

THE ANCIENT MINES OF USSEGLIO (TORINO, ITALY) MULTI-YEAR PROGRAMME OF RECORDING, STUDY, PRESERVATION AND CULTURAL DEVELOPMENT OF THE ARCHAEOLOGICAL MINING HERITAGE IN AN ALPINE VALLEY

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The programme started in 2001 and developed a large set of operations in order to create a geo-topographic and historical-environmental database, to rebuild the chronology (relative and absolute) of mining works in the Punta Corna complex (high Arnàs and Servìn valleys) and the extractive activities' effects on the Usseglio economy and more broadly on Lanzo Valleys economy.

The main part of the operations has been conducted directly by the Civic Alpine Museum staff, but in some aspects (such as deciphering medieval documents, mineralogy, petrography, GNSS surveys, aerial photography, restoration of the steel archaeo-mining finds, and so on), a strict co-operation with university teachers and other specialists or qualified technical figures was requested and realized.

This open and multi-disciplinary approach will guarantee, also into the future, the best exploration and knowledge of this enormous heritage.

According to the experience of the senior archaeologists (responsible to the Civic Alpine Museum), a group of underground experts – mining engineers and speleologists specialized in artificial cavities – will carry out explorations and surveys, to collect precious information connected to the external records.

1. Topography and Geology

The Punta Corna mountain mining complex is located on the left side of the Arnàs stream valley (western Po basin), spreading from 2,250 to 2,900 m a.s.l. (main peaks attain 2,930 up to 3,108 m a.s.l.), between Rossa Lake (hydroelectric storage near French border, 2,718 m a.s.l.) westwards and Torre d'Ovarda mountain group (3,075 m a.s.l.) eastwards.

The siderite and Co-Fe-Ni arsenides mineralisations belong to a trending system of post-metamorphic hydrothermal veins, mainly within the metabasites of the Piemonte Zone. These veins formed because of the circulation of hydrothermal fluids along extensional structures linked to brittle deformation events which affected the rocks at the end of the Alpine orogenesis.

The mining complex is protected by the institution of a 10 km² area, wherein the mineral collection and the removal of man-made objects are totally forbidden.

2. Aerial reconnaissance and field survey of archaic mines

Aerial reconnaissance and field survey point out a strip of some kilometres long, up to 10 m wide and 12 m deep, open air trenches, issued from archaic iron ores mining; their order of magnitude is equal to today's industrial plants, like roads, hydroelectric power plants or dams.

These trenches are associated with pits, ditches, descending galleries (often intentionally back-filled after the end of the exploitation), sinkholes, undermined boulders, spoil banks, remnants of little rough-stone half-buried buildings and also walls, used for terracing, ore crushing and picking, sheltering gallery entrances and closing natural rock-shelters.

3. Technical features of archaic exploitation

The exploitation was focused on iron hydroxides (limonite, goethite), resulting from siderite decay. The fragmentation was strictly limited to mineralised veins, particularly in upper and softer levels; it halted when reaching inner and harder levels of massive, un-weathered iron carbonates (siderite). No drill holes and only rare tool marks are visible on the trench sidewalls. Miners used steel hand tools, occasionally found near the trenches during field survey.

4. Present look of trenches

Today, iron ores are seldom visible in the open air, because they have been nearly completely removed by the exploiters. Trenches are partly occupied by unremoved

boulders and panels of the embedding rock, so their bottom is presently unattainable; nevertheless, they seem sometimes to be connected to descending gallery entrances in lower levels. Sidewalls are generally stable; widespread spoil banks run along the ditches.

5. Present look of pits, ditches and sink-holes

All these features are excavated under main boulders, which shelter the access to veins; they are circular, oval or funnel-shaped, placed above buried veins, flanked by little, mound-shaped spoil banks, obstructed by post-functional collapses

Figure 1. Trenches R1-201 and R1-202 (left); iron hydroxides and embedding rock panels in trench T1-202 (right).

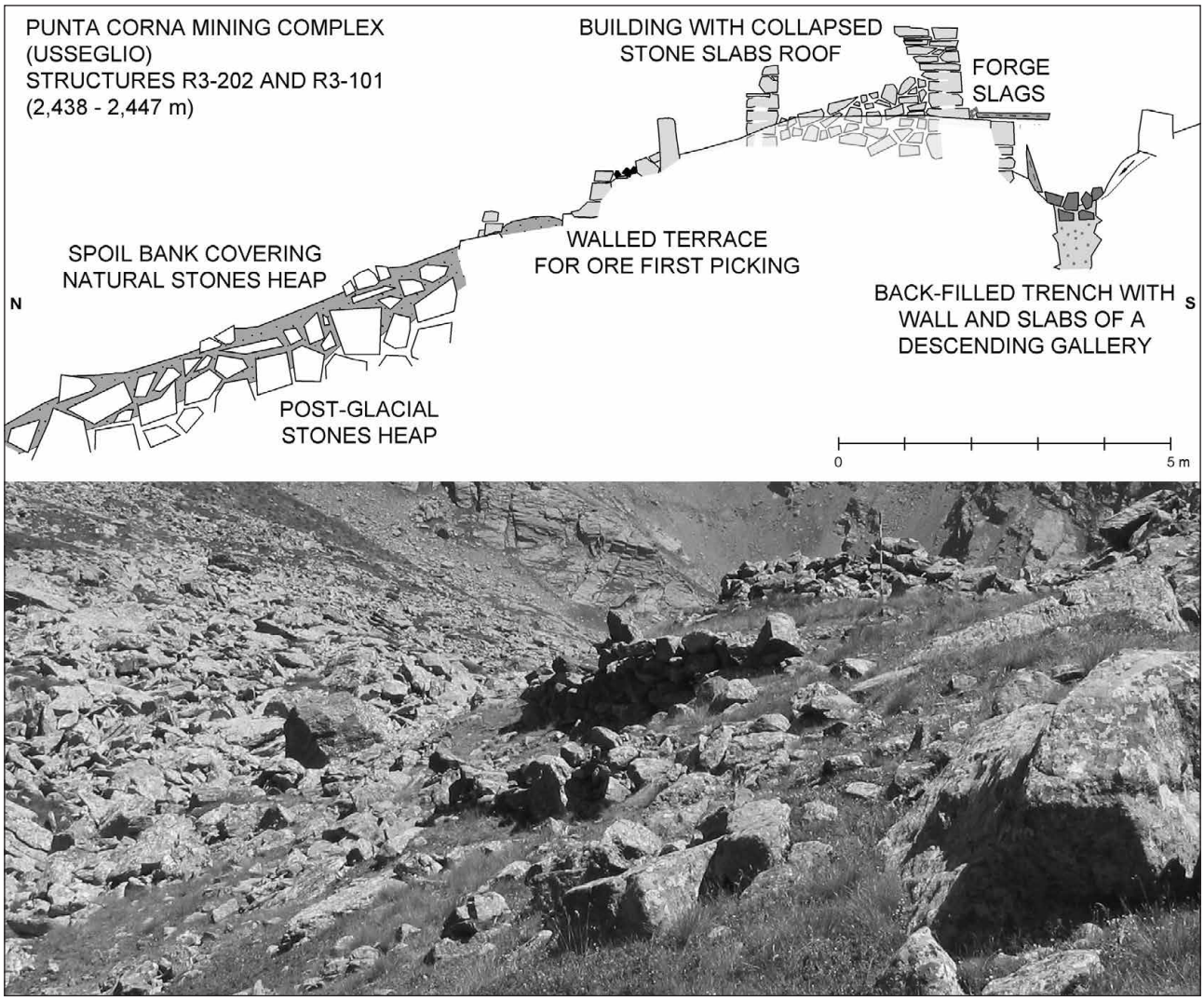

Figure 2. Vertical section and photographic view of a typical archaic plant.

or back-filled after the end of the exploitation. Underground, rough-stone walls, slabs and stairs are preserved for few metres.

In general, the structures are well preserved in comparison with their working time, because of scarce post-functional colluvium.

6. Pre-blasting mining

Gunpowder use in mining activities begins in the 17th century: the first statements in the Duchy of Savoy date from 1671, in the Duchy of Milan from 1665.

The organization of a pre-blasting mining exploitation, possibly similar to the Usseglio examples, can be observed in the polyptych by Hans Hesse (1522) for the altar of mine workers in the Church of St. Anne at Annaberg-Buchholz (Herzgebirge, Sachsen, Germany).

7. Chronology

The dating of archaic exploitation to the middle ages is based on archaeological finds, particularly steel tools (12th–14th century) and pottery (11th–13th century), and on historical documents, referring to mining activity, cast iron, steel and silver production, and ore thefts, in the years 1264 (already carrying on previous contracts), 1316, 1318, 1333, 1335, 1402, 1438, and 1515.

8. The age of cobalt

Since 1753, after a long period of scarce production, a new chapter begins, because of the discovery of cobalt ores, exploited by Counts Rebuffo di Traves alongside copper and silver (cobalt-iron-nickel arsenides with tetrahedrites).

Two maps, dating to 1758–1772, mark the exact positions and directions of several veins. In 1758, a building named "*Casere*", much larger than medieval ones, was built at an altitude of 2,625 m a.s.l. near Veil Lake to house the workers.

9. A proto-industrial perspective

The exploitation is no longer opencast mining, but moves mainly underground, with several multi-level grids, sometimes intercepting former works, in an incoming proto-industrial perspective.

Two new buildings are constructed before 1815, at 2,374 and 2,439 m a.s.l. respectively. Both are recorded in a mine section dating to 1823, near the entrance of crosscuts.

10. Paper maps and material reality

Even today, veins, galleries, spoil banks and buildings reported by mine sections and maps can be identified in the field. However, galleries and stopes are mostly inaccessible, because of landslides, or dangerous, because of the collapse of timbering.

Documents reveal to us that sometimes miners lived in very hard conditions: the "Dwelling of Workers" ("*Abitatione de Lauoranti*"), recorded by a map, in 1758–1772, at the foot of "St. Mary Mine" ("*Caua di S. Maria*"), was a walled prehistory-like rock-shelter, still used occasionally in the 1920s by the last prospectors.

11. Protecting the entrances

To reach the deposit bed, that was hidden by a thick layer of debris, miners built some long galleries into such sediments, protected by side walls and roofed by rough-stone slabs. One of the most impressive linked a dwelling to the real lower entrance of a mine, that was cut in hard rock: in that way, miners avoided blockages of the entrance by landslides or by avalanches and avoided long removal works in spring, when restarting the exploitation after the

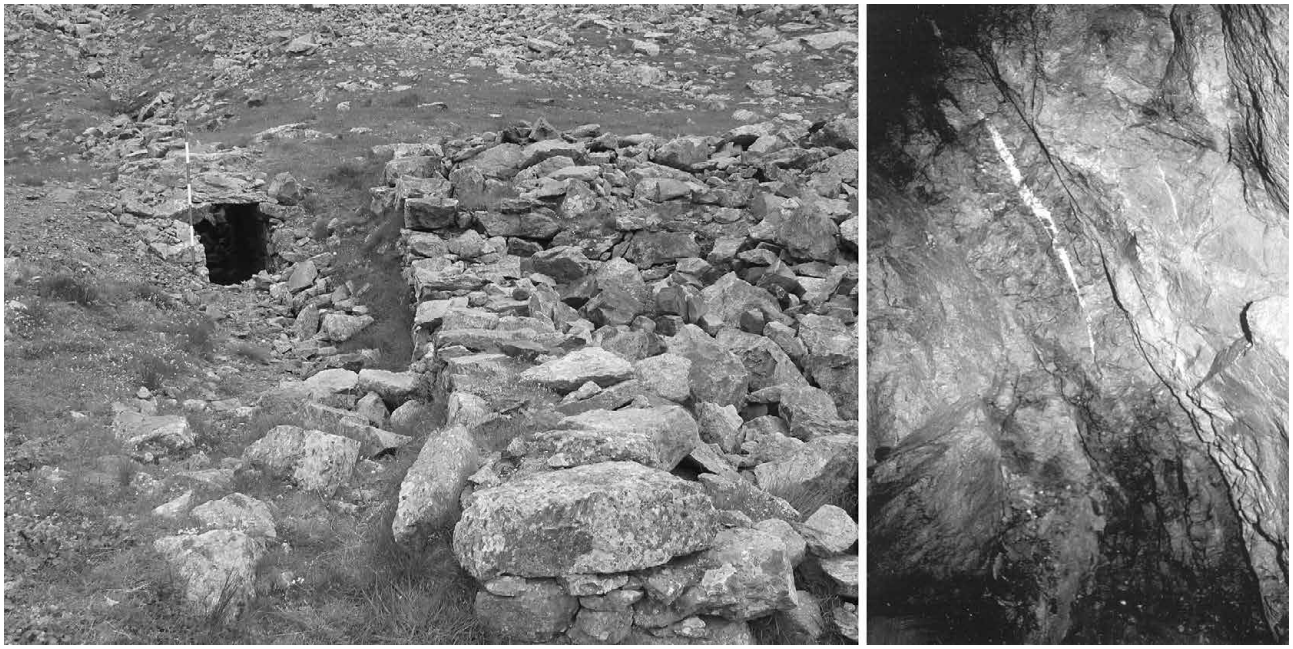

Figure 3. Ruins of a modern dwelling, linked to an underground grid by a gallery, built into the debris (left); an example of a subterranean vein (right).

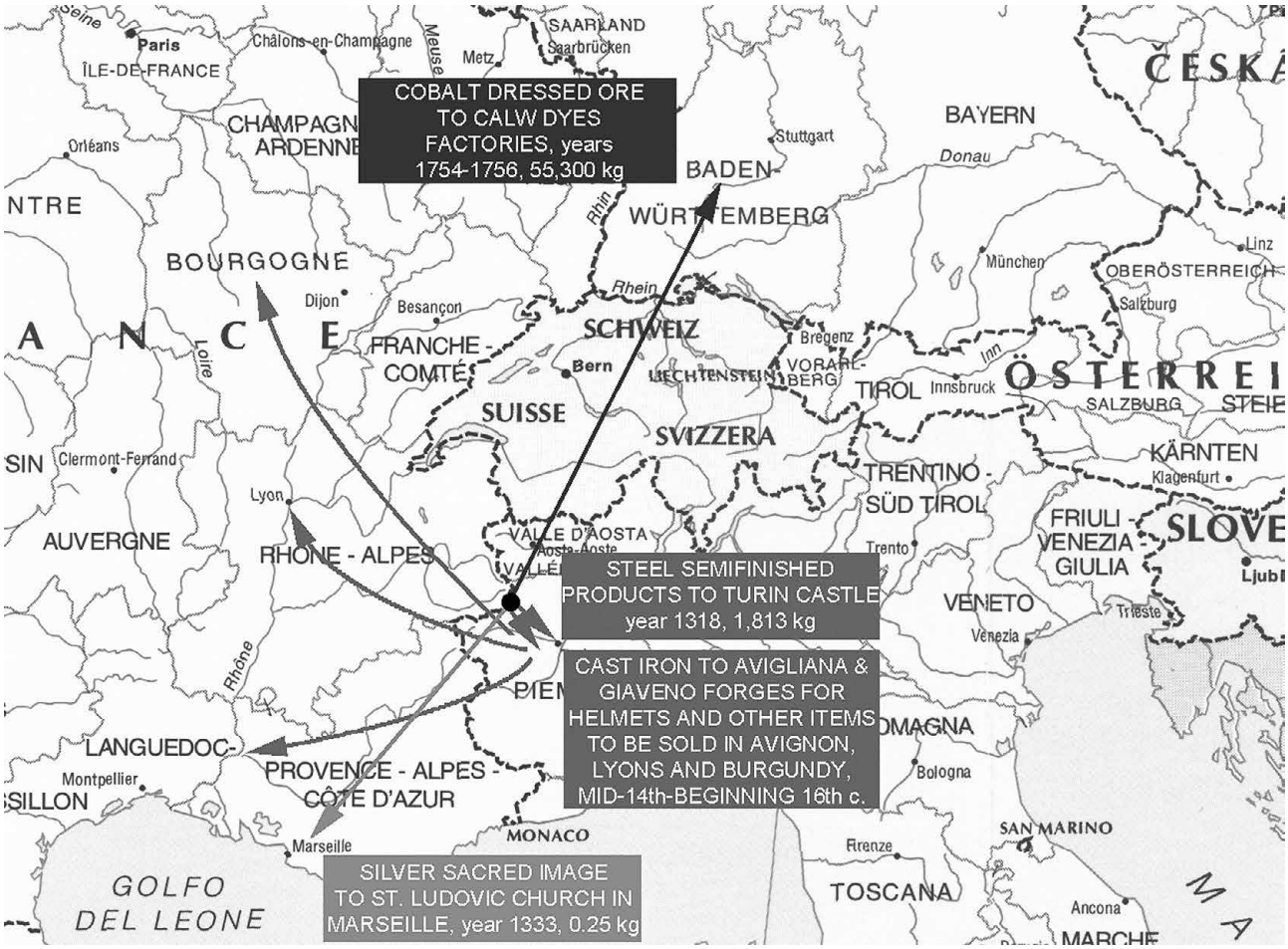

Figure 4. Not just a local market: international routes from Usseglio to European destinations.

winter inactivity (documents inform us that the season lasted no more than four to six months).

12. Observing the veins

Veins can be observed underground, where the exploitation stopped: they show a series of parallel, almost vertical bands, with a lot of gangue.

13. The "cobalt factory"

The Usseglio built-up area still hosts the "*Cobalt Factory*", at 1,290 m a.s.l. in Crot hamlet, built in 1755–1757 according to a plant model imported from Saxony and Bohemia by S.B. Nicolis di Robilant (1724–1801), general inspector of the mines of the Kingdom of Sardinia (1752–1773).

The dressed ore that was produced by this plant was exported to Württemberg (55 tons up to 1756). The original look of the building is recorded by maps and drawings dating to the period 1823–1854.

14. From factory to hotel

The factory was then enlarged and modified, in 1896 becoming one of the earlier hotels devoted to the rising mountain tourism, with the evocative appellation "*Albergo Miniere*" ("*Mines Hotel*"). Today it is a stop on the external itinerary of the Civic Alpine Museum.

15. Working plan 2013

Following the Museum programmes, in order to increase and to develop our knowledge of the territory, in summer 2013 a lot of new studies are going to start:

- recording and topography of archaic mines located in the area, in safe conditions;
- underground survey of mining, according to speleological/archaeological standards;
- multidisciplinary study of cavities and associated evidence (mineralogical, mining, wildlife, archaeobotanic, etc.).

16. In conclusion

One of the statutory aims of the Civic Alpine Museum of Usseglio, entirely volunteer-conducted, is the "systematic recording and cultural development of the historic heritage of sciences and techniques". The Museum's researchers, with the decisive aid of several colleagues of other institutions, are carrying out a full survey of archaeological mining structures in relationship to geological, technological, historical and iconographic data.

The state of preservation of this heritage is remarkably good, as the area is geologically stable, vegetation is almost absent, mining has been suddenly abandoned and no subsequent activities but pastoral farming have taken place.

Several sites are accessible to the public in summer and at the beginning of autumn, as the Museum organizes workshops including guided tours in the Punta Corna protected area.

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