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Touristic Fruition of the Disused Quarry of Busca Onyx: Problematics and Strategies

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Geoheritage

Touristic fruition of the disused quarry of Busca Onyx: problematics and strategies

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Touristic fruition of the disused quarry of *Busca Onyx*: problematics and strategies

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Abstract

The paper presents the geotouristic project carried out on *Busca Onyx* quarry (Piedmont, Italy). *Busca Onyx* (also called Busca Alabaster) is an ornamental stone quarried from the XVII century until the early years of 1900, when the quarry was closed. This stone was greatly appreciated by the architects working for the House of Savoy who used this material in the decorative apparatus of many churches and civil buildings mainly in Turin, the ancient seat of the House. The quarry site is very interesting from both geological and historical point of views. The area is characterized by paleokarst formations and the deposits developed in an ancient cave system. Despite its name, *Busca Onyx* is a speleothem derived rock (calcite-alabaster). The peculiarity of the quarry lies in its morphology, in fact it is composed of four artificial canyons exploited in the side of the hill. The canyons are around 100 m long, 2-3 m wide and up to 40 m deep, determining a landscape, which is very suggestive for tourists and excursionists. Nowadays the quarry is abandoned and the site can be used for didactic and geotouristic purposes, in fact, a characterization project recently started. *Busca Onyx* and its quarry were characterized using a multidisciplinary approach, linking data obtained from geoscience studies (such as mineralogy, petrography, geochemistry, geomorphology, etc.) to local history. All the information obtained through the characterization project describe a complex geological and environmental system, which is also a precious site for local cultural enhancement.

Keywords: quarry, ornamental stone, geotourism, Piedmont, calcite-alabaster

Introduction

Dimension stones have always been recognized as one of the most important natural resource for construction and building; in particular, as they have been used as raw materials for masterpieces of sculpture and for architectural elements, they are representative of worldwide cultural heritage. Therefore, the knowledge of stone resources (the mineralogical and petrographic features, their applications and exploitation techniques from ancient times to the present, etc.) can provide a broad overview of the historical and cultural significance of such materials, highlighting the relevance of an economic activity so important for the history and traditions of different cultures developed through the centuries all over the Mediterranean area. In particular, in the Piedmont region (NW Italy), stone has always been the most widespread building material, characterizing the strong architectural identity of the city of Turin (Fiora et al. 2001; Fiora et al. 2007, Badino et al. 2001, Borghi et al. 2014, Sandrone et al. 2004) playing a fundamental role in regional architecture and artistic expression. In fact, many kind of local rocks constituted the main building material for centuries, and the varieties that displayed aesthetical features were also used as decorative stones. A fine variety of ornamental stone from Piedmont is *Busca Onyx* employed in art and architecture since the end of XVII century. Main applications were in the

1 decoration of churches and buildings and for small statuary elements. Despite its name, *Busca Onyx* is a calcite-alabaster
2 (as defined by Klemm and Klemm, 1991) a sedimentary rock originated in sub-aerial environments by the precipitation
3 of calcite layers. The rock and the quarry were deeply investigated with a multidisciplinary approach; the characterization
4 project dealt with many aspects as: the description of the quarry site, reconstruction of its history, study of the depositional
5 environment (genetic mechanisms of *Busca Onyx*) and mineralogical and petrographic characterization of the rock
6 (Marengo 2107). *Busca Onyx* formed in a complex setting that is no longer preserved, since the quarrying activities altered
7 the original morphology of the landscape. Nevertheless, features of karst environments are still recognizable in the area
8 (e.g. the presence of a small cave¹) implying the presence of speleothems and the possibility to carry on paleoclimatic
9 reconstruction for a geographical area which has never been investigated before by this point of view. Preliminary U/Th
10 dating on stalactite samples shows the possibility to carry on paleoclimatic and paleoenvironmental studies on a timespan
11 ranging from 320.000 to 50.000 years ago. In addition to scientific relevance, *Busca Onyx* is also a resource with some
12 importance in cultural heritage, since the quarry was owned by the House of Savoy and was greatly appreciated by famous
13 artists as Filippo Juvarra. The aim of this article is to describe the quarry of *Busca Onyx* and to illustrate its geotouristic
14 potential. *Busca Onyx* quarry can be seen as a “geoattractor” (a potential node of the local geotouristic network, as defined
15 by Margiotta and Sansò 2017) implying that its conservation and promotion is a fundamental aspect to consider. In this
16 optic, the University of Turin cooperated with the Municipal Administration of Busca to enhance the site, involving the
17 local administration in an academic project. As pointed by Zunino et al. 2012, Piedmont is a region characterized by a
18 heterogeneous patchwork of geological peculiarities that need to become public knowledge, thus it is important to propose
19 new geoheritage projects, especially outside of protected areas, stimulating the creation of new safeguards of our
20 geological heritage.
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31 32 33 **Study Area**

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35 The *Busca Onyx* quarry is located in southwestern Piedmont (NW Italy), near the town of Busca, in the Cuneo province
36 (Fig. 1a). It lies between Varaita and Maira valleys (Cottian Alps). Precisely, on the south-eastern side of the “Eremo di
37 Belmonte” hill, in an area called “La Marmorera”, a name that refers to the past quarrying activity. The quarry is in an
38 easily accessible position, few kilometers west of the residential area of Busca. By a geological point of view, the Busca
39 quarry is situated in the southern sector of Dora-Maira Massif, that represents the basement nappe of the inner Penninic
40 Domain of Western Alps together with Monte Rosa and Gran Paradiso Massifs. Dora-Maira Massif is characterized by
41 the occurrence of high-pressure metamorphic assemblages and in particular it is the ellipsoid-shaped crystalline basement
42 of the Cottian Alps. Its extension is about 70 x 25 km (Chopin et al. 1991) and consists of tectonic slices of continental
43 basement with different early-Alpine peak-pressure metamorphism. The host rock of Busca carbonate deposits is a
44 partially karstified dolomitic marble (Fig. 1b) that belongs to the metamorphic Mesozoic cover of the southern sector of
45 the Massif (Sandrone et al. 1993).
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60 ¹Originally existed other caves in the area, completely destroyed by the quarry exploitation.
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Topography of *Busca Onyx* quarry

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2 Quarries constitute an extreme man-made reshaping of the natural landscape (Nita 2012), as pointed out by Prosser (2016)
3 mineral or rock extraction processes can damage or destroy potential elements of geoheritage, especially where it
4 coincides with finite features such as caves. However, also in this cases, opportunities for geoconservation can arise. At
5 present day, *Busca Onyx* quarry is no longer in activity. Its area is characterized by four artificial canyons (Fig. 2a)
6 obtained removing carbonate concretion, whether it was thick enough to be extracted in blocks and used as ornamental
7 stone. The extracted rock is known by the commercial denominations of *Busca Onyx Marble* (or most commonly *Busca*
8 *Onyx*) and *Busca Alabaster*. The deposits consisted of thick layers of carbonate concretions originated by water
9 percolating into an ancient cave/fracture system and, as observed in similar cases (e.g. Fairchild and Baker 2012), the
10 outcome was the coexistence of horizontal high flow component, flowstones (Fig. 2b), and vertical slow flow component
11 (stalactites and stalagmites). The present-day artificial canyons are nearly parallel and oriented along a NW-SE direction,
12 a few meters wide and up to 35 meters high (Fig. 3). Their length ranges between 50 and 100 meters. The calcite-alabaster
13 deposits were. Most of the concretion had been carried out leaving the bare host rock, which is partially marked with tool
14 marks left by the different extraction techniques employed. The surface of the hill is characterized by a thick soil with a
15 rich vegetation cover, which partially hides the karst topography. The only area that preserves the original morphology
16 of the ancient carbonate deposit is represented by the Marmorera Cave, which is located at the far end of canyon C4. It
17 has been explored and mapped for the first time by Spissu et al. (2000) and registered to the “Italian Caves Cadaster”
18 (cave number PI CN 1195). It is a narrow cavity, around 10 meters in depth, that develops for around 20 meters along
19 NW direction (coherently with the direction of the canyons). The cave is accessible from the present ground level of
20 canyon C4. The most important feature of the cave is that it is the only site in the whole area which was almost not
21 modified by human interactions and preserves its original morphology. Moreover, the presence of a thick concretion layer
22 below the ground level demonstrates that the quarry is not exhausted as it was believed in past. Typical features of karst
23 environments are still recognizable in the area and the petrographic analysis, on both extracted material and samples
24 collected *in situ*, confirmed its spelean nature (Marengo 2017).
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Busca Onyx in cultural heritage: local history and applications

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39 Quarries can also describe the interaction between anthropic activity and georesource exploitation within a defined time
40 interval (Tom and Gurli 2015). Documents and manuscripts found in the Historical Municipal Archive of Busca and in
41 the State Archives of Turin, along with other historical sources, were used to reconstruct a chronology of *Busca Onyx*
42 exploitation. Unfortunately, it is not possible to collocate precisely the beginning of the exploitation of the quarry. Eandi
43 (1833) suggests that the exploitation began in 1640-1650 (successively supported by Casalis 1834; Barelli 1835; Stella
44 1908). Ocelli (1930) states that in 1696, the property of the quarry site was transferred from the City of Busca to Emanuele
45 Filiberto of Savoy, Prince of Carignano (1628-1709). The oldest document related to the quarry dates to 1696; it is an
46 agreement between the Prefect of Busca and the patrimonial administration of House of Savoy. It contained instructions
47 on the supply of *Busca Onyx* and on its employment in the decorative apparatus of the Church of St. Filippo Neri in Turin.
48 The period of greatest activity of the quarry had been between the second half of the XVIII century and the middle of the
49 XIX century. *Busca Onyx* has been used for sacred and civil buildings, especially in Piedmont. During the Napoleonic
50 domination the quarries were still part of the goods of the Crown, then, in 1814 the property was assigned to the Regio
51 Demanio. Historical reports agree to state that in the second half of the XIX century, the quarry started an economic
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1 decline period. It had no continuity of business; in fact, the rock was occasionally extracted, only when architects or artists
2 requested it for supplies (Di Saluzzo 1845). In a document dated 1874, it is mentioned that the quarry site is abandoned.
3 In 1879 the site was sold to Senator Carlo Brunet who reopened the quarry, his heirs ceded the property it in 1902 to an
4 entrepreneur who sold it in 1927 to the family that still owns the land. The geologist Augusto Stella visited the quarry in
5 1908 and wrote: “*the quarry [...] is managed in a primitive way, it certainly lacks of any rational organization. It is*
6 *unthinkable to make a high profit out of this material, as it should be supposed to*”. The production gradually decreased
7 and stopped permanently in 1961.
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10 ***Applications in Cultural Heritage***

11 *Busca Onyx* was extensively employed in cultural heritage, mainly for small artistic objects such as vases and statuettes;
12 and, in architecture, taking account of its scarce coherence, it has only been used in interior applications as decorations in
13 churches, royal residences and aristocratic palaces, e.g. decorative wall panels, furniture cover plates, columns,
14 balustrades. The area of diffusion of this ornamental stone comprises Cuneo and Turin provinces; but it was appreciated
15 especially in the city of Turin, the ancient seat of the House of Savoy. Nevertheless, information of objects carved in
16 *Busca Onyx* have also been found in America: an altar in St. Mary Church in Rochester, New York, USA (1953) and a
17 table clock in a private collection in Bowmanville in Ontario, Canada (1905). One of the most impressive example of
18 application is the church of St. Filippo Neri, the biggest church of Turin, designed by the Royal Architect Filippo Juvarra.
19 *Busca Onyx* was employed for the columns delimiting the nave, for the balustrades and for the main altar characterized
20 by six Solomonic columns covered by *Busca Onyx* (Fig. 4a). Among the most iconic buildings in Turin there is the
21 Basilica of Superga and its Crypt, the main burial site of the House of Savoy family members. *Busca Onyx* had been
22 employed in both the Church and the Crypt for wall panels, sculptures, urns and pedestals. In Fig. 4b, the Sarcophagus of
23 King Carlo Alberto, last King of Sardinia, is reported. The top is made in *Busca Onyx* and decorated with white marble
24 angels. Other examples of application are the decorative apparatuses of the Royal Church of San Lorenzo (Turin), Church
25 of St. Teresa (Turin), Church of St. Tommaso (Turin), Church of St. Francesco d’Assisi (Turin), Beaumont Gallery in
26 Royal Palace (Turin), St. Donato Cathedral (Mondovì, Cuneo) where the interior is characterized by the presence of
27 pilasters painted reproducing *Busca Onyx* pattern (Fig. 4c), Regina Monti Regalis Sanctuary (Vicoforte, Cuneo). *Busca*
28 *Onyx* owns its fortune to the Royal Architect in Turin Filippo Juvarra (1678-1736) and later to his nephew Francesco
29 Martinez (1718-1777), who both loved this material and employed it in their decorative projects. Besides architect
30 Francesco Gallo (1672-1750), who worked also in Cuneo province, used this material for his projects. Furthermore, *Busca*
31 *Onyx* was used also for decorative elements in private residences, the most famous example is the fireplace in Napoleon’s
32 room at Bonaparte residence in Ajaccio (Corsica, France).
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49 **The quarry as potential geotouristic attraction**

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51 The information obtained through the multidisciplinary characterization project carried out on the quarry and on the rock
52 describe a complex geological and environmental system, which is also a designed site for cultural enhancement. In fact,
53 beyond displaying geological structures and peculiar environments as caves, the quarry may provide knowledge of ancient
54 technology, social organization, trade and communication. After the last years of activity of the quarry, the site was
55 abandoned and its existence and location were nearly forgotten even by the local population. Considering the peculiar
56 morphology of the quarry, which could be very suggestive for excursionists, in 2015 the Department of Earth Science of
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1 the University of Turin and the Municipality of Busca committed in a project that entails the valorization of the quarry
2 area and its preparation for touristic fruition. The cooperation of academic researchers and municipal administrators had
3 two main objectives on medium-long terms. The first is the valorization of the area through a deepened scientific study
4 of both the quarry and the extracted material; the second is the touristic fruition of the quarry area through the creation of
5 a geotouristic itinerary. The first steps of the valorization process were the diffusion of the achieved results through
6 lectures and seminars. The characterization project also aimed at a wider, non-specialist, audience and the results of the
7 study were collected in an educational book on *Busca Onyx* and its quarry (Marengo and Costa, 2016).
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10 ***Track itinerary***

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13 A basic geotouristic itinerary was proposed for the quarry site. The track starts from canyon C3 (Fig. 5a) (the second
14 biggest canyon, 78 m long and 2.5 m wide). Entering the canyon, the first feature to observe are the host rock walls
15 constituted by a compact light gray marble, sometimes showing a red coat (clay and iron compounds). In some areas of
16 the canyon, thin layers of concretion in its original bedding is still visible. The second stop inside quarry C3 allows to
17 appreciate its particular morphology. The artificial shape of the canyon is interposed between a trench and a gallery, due
18 to the irregular shape of the original calcite-alabaster deposit. Last stop in quarry C3 permits to observe a geological
19 phenomenon in progress: near the end of the canyon water still drains and percolates on the quarry walls, leaving thin
20 layers of carbonate deposition (Fig. 5b). Throughout the whole quarry it is possible to observe different kind of concretion
21 and speleothems (Fig.5 c and d). The widest part of the area is inactive by a depositional point of view, due to the deep
22 anthropogenic modifications occurred during quarrying activities, except for some limited parts of canyon C3 and
23 Marmorera Cave in which speleothem deposition is still verified. Outside canyon C3 there is a panoramic point open
24 towards the plain and the residential area of Busca. Following the path to the entrance of canyon C4 the ruins of a small
25 building can be observed: they consist of an abandoned warehouse employed to store digging tools and other materials.
26 Canyon C4 is the most extended (96 m long, up to 4 m wide) after entering, the first stop is located at the foot of the
27 impressing 35 m high wall completely covered by tool marks (Fig. 5e). From the top to the bottom, there can be found at
28 least 4 different types of marks. The use of drills is still well recognizable; shot holes were carved in the rock in strategic
29 positions and filled with weak explosive charges. Small narrow trenches were carved in the rock with hammer and chisel,
30 pickaxes, saws or drills. Carving with chisels generally leaves straight parallel lines while the use of picks or pickaxes is
31 proved by curved parallel grooves. Both tools were rather common, still after the industrial revolution. Traces ascribable
32 to mechanized extraction of blocks are recognizable by the more regular and thick pattern they produce. Last point of
33 interest is the entrance to the Marmorera Cave. The cave is not accessible to the public because to its morphology, but
34 from the entrance thick layers of flowstone are visible. The tour ends outside canyon C4 where the excursionists can
35 continue the visit following the naturalistic paths created and promoted by the local administration. Informative panels
36 and a small collection of old photographs are displayed at some stops and can be consulted during the tour. In 2016 and
37 2017, the track was tested in three pilot events, related to the enhancement of *Busca Onyx*, that involved a total of three
38 hundred visitors.
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53 ***Conservation challenges***

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56 In order to prepare the site for touristic fruition, it had been necessary to consider conservation problematics. As pointed
57 out by Margiotta and Sansò 2017, dismissed quarries are critical factors for public safety if they do not receive any
58 restoration treatment at the end of industrial activities, and this properly reflects Busca quarry's situation. Morphological
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1 elements of the quarry include slopes, cliffs, roads and ramps, any of them representing features that require different
2 restoration and arrangements. Vertical cliffs constitute the most defining feature of a quarry, they quickly begin to weather
3 and degrade (Nita 2012) and since *Busca Onyx* quarry is greatly constituted by vertical walls, conservation problematics
4 concern mainly the safety of the visitors, considering that the risk of detachment of material from the quarry walls could
5 be a limiting factor of its geotouristic development. For this reason, consolidation is planned after a preventive dissection
6 of the walls of the canyons. An adequate transiting of the surroundings of excavations along the slope of the hill, where
7 the stone matrix is extracted, will be arranged. Concerning the weathering and the conservation of original features, the
8 main issue is the vegetal colonization boosted by the wet climate and by the fertile soil. Spontaneous trees and shrubs
9 grow inside the canyons partially obstructing the access and the passage in the trenches (Fig. 6a). Vines inflict the major
10 damage and climbing plant roots carve millimetric paths in the rock surface, enhancing weathering and erasing superficial
11 features (both natural and artificial, the main danger is the damage to the ancient tool marks). The presence of lichens is
12 also massive and dangerous for the cohesion of the superficial layers of rock (Fig. 6b). In 2016, the area was organized
13 and partially cleared from the vegetation to allow the first guided tours through the site. Panels with data obtained from
14 the multidisciplinary characterization of the rock and of the quarry are displayed in situ in order to make tourist aware of
15 the geological and environmental features of the area along with safeguard and conservation problematics.
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25 **Conclusions**

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27 An important component of geoconservation is the promotion of research and education, in order to increase the
28 understanding of a site and to build support for its conservation, through increasing the value that the community near to
29 the quarry places upon it (Prosser 2016). This process is already ongoing in Busca, starting from the close collaboration
30 of University, Municipality and locals, to the achievement of the first medium-term objectives of the institutional
31 cooperation. By now, the project led to three main results: the awareness of the quarry role in local history, the scientific
32 knowledge derived from the characterization project, and the impact of the site as potential geotouristic attraction. Nita
33 (2012) states that quarries can be useful for geotourism if they fulfil precise functions: scientific, educational, evocative,
34 practical, touristic and leisure. In its small area, *Busca Onyx* quarry could operate all these functions. From the scientific
35 point of view, the mineralogy and petrography of the area are rich and interesting; moreover, the site contains a potential
36 record of paleoclimatic evolution (Marmorera Cave) that can cover an extended timespan that is rarely found in other
37 locations in Western Alps. Educational opportunities in the site can be offered for tourists of all ages, showing both natural
38 and artificial features. The area covered by the quarry contains also evocative elements and well-exposed typical quarry
39 features, such as cliffs, spoil heaps and tool marks. Other interesting touristic sites are spread all over Busca urban area
40 giving a wide option to the tourists to continue their experience after visiting the quarry, which lies in an easily accessible
41 position and near to other cultural and historical sites as the Eremo Monastery and the Roccolo Castle.
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52 **Acknowledgements**

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54 The authors wish to thank the Municipal Administration of the City of Busca for the support to the project.
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References

- 1
2 Badino V, Bottino I, Bottin G, Fornaro M, Frisa Morandini A, Gomez Serito M, Marini P (2001) Valorizzazione delle
3 risorse lapidee del bacino estrattivo dei marmi del monregalese. *Geingegneria Ambientale e Mineraria* XXXVIII:97-
4 108.
5
6
7 Barelli V (1835) Cenni di statistica mineralogica degli Stati di S.M. il Re di Sardegna ovvero Catalogo ragionato della
8 raccolta formatasi presso l'Azienda Generale dell'Interno. Fodratto, Torino, 1-687.
9
10
11 Borghi A, d'Atri A, Martire L, Castelli D, Costa E, Dino G, Favero Longo SE, Ferrando S, Gallo LM, Giardino M,
12 Groppo C, Piervittori R, Rolfo F, Rossetti P, Vaggelli G. (2014) Fragments of the Western Alpine Chain as Historic
13 Ornamental Stones in Turin (Italy): Enhancement of Urban Geological Heritage through Geotourism. *Geoher* 6:41-55.
14
15
16 Casalis G (1834) Dizionario geografico, storico, statistico, commerciale degli Stati di S.M. il Re di Sardegna, vol. II and
17 XIV. Maspero e Marzorati, Torino.
18
19
20 Chopin C, Henry C, Michard A (1991) Geology and petrology of the coesite-bearing terrain, Dora Maira massif, Western
21 Alps. *Eur J Mineral* 3:263-291.
22
23
24 Di Saluzzo A (1845) Le Alpi che cingono l'Italia considerate militarmente così nell'antica così come nella presente loro
25 condizione. Mussano Edition, Torino, 107-108.
26
27
28 Eandi G (1833) Statistica della Provincia di Saluzzo, vol. I. Lobetti-Bodoni Typography, Saluzzo.
29
30 Fairchild IJ, Baker A (2012) *Speleothem Science – From process to past environments*, Wiley-Blackwell, 431.
31
32 Fiora L, Carando M, Sandrone R (2007) Multimedia petrographic guide of the city of Torino, Italy. *Per Miner* 76:91-97.
33
34 Fiora L, De Rossi A, Sandrone R, Alciati L (2001) Esempi di pavimentazioni lapidee storiche e contemporanee nella città
35 di Torino. *Geingegneria Ambientale e Mineraria* XXXVIII:271-276.
36
37
38 Klemm DD and Klemm R (1991) Calcit-Alabaster oder Travertin? *Göttinger Miscellen* 122: 57-70.
39
40
41 Marengo A (2017) Mineralogical and petrographic characterization of calcite-alabaster. The case study of Busca Onyx.
42 *Plinius* 43, *in press*.
43
44 Marengo A, Borghi A, Cadoppi P, Costa E. (2014) The Busca Onyx: an historical ornamental stone from Piedmont. In:
45 *Research and Preservation of Ancient Mining Areas*, IES Yearbook, 289-299. Silvertant ed., Valkenburg ,171-181.
46
47
48 Marengo A, Costa E (2016) *L'Alabastro di Busca tra Arte e Scienza*, 160pp. ISBN 972-12-200-1174-7.
49
50
51 Margiotta S, Sansò P (2017) Abandoned Quarries and Geotourism: an Opportunity for the Salento Quarry District
52 (Apulia, Southern Italy). *Geoher* 9: 463-477.
53
54
55 Nita J (2012) Quarries in landscape and geotourism. *Geographia Polonica* 85:5-12.
56
57
58 Ocelli S (1930) *Busca nei tempi antichi e moderni*. Ed. Marchisio, Turin, 260.
59
60
61 Prosser CD (2016) *Geoconservation, Quarrying and Mining: Opportunities and Challenges Illustrated Through Working
62 in Partnership with the Mineral Extraction Industry in England*. *Geoher*. <https://doi.org/10.1007/s12371-016-0206-z>.
63
64
65

1 Sandrone R, Cadoppi P, Sacchi R, Vialon P (1993) The Dora-Maira Massif. In: Pre-Mesozoic Geology in the Alps, von
2 Raumer JF and Neubauer F (Eds). Springer-Verlag, 317-325.

3 Sandrone R, Colombo A, Fiora L, Fornaro M, Lovera E, Tunesi A, Cavallo A (2004) Contemporary natural stones from
4 the Italian Western Alps (Piedmont and Aosta Valley regions). *Per Min* 73: 211-226.

5 Spissu M, Elia E, Lerda M, Chesta M. (2000) Grotta della Marmorera. *Mondo Ipogeo* 15.

6
7 Stella A (1908) Le cave di alabastro e di altri materiali calcarei del Saluzzese. *Bollettino del Regio Comitato Geologico*
8 d'Italia 4.

9 Tom H, Gurli M (2015) Assessment of ancient stone quarry landscape as heritage sites. *Engineering Geology for Society*
10 and Territory 8: 253-256.

11 Zunino M, Cavagna S, Clari P, Pavia G (2012) Two Examples of the Geoheritage Potential of Piedmont (NW Italy):
12 Verrua Savoia for the Present, Valle Ceppi for the Future. *Geoher* 4:165-175.

13 Captions

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28 **Fig. 1** a) geographical location of Busca, Piedmont, NW Italy. b) Geological map of the southern sector of Dora Maira
29 Massif (*Carte géologique de la France* 1:250 000 – Sheet 32-10 Gap). Busca quarry area is highlighted by the yellow
30 circle.

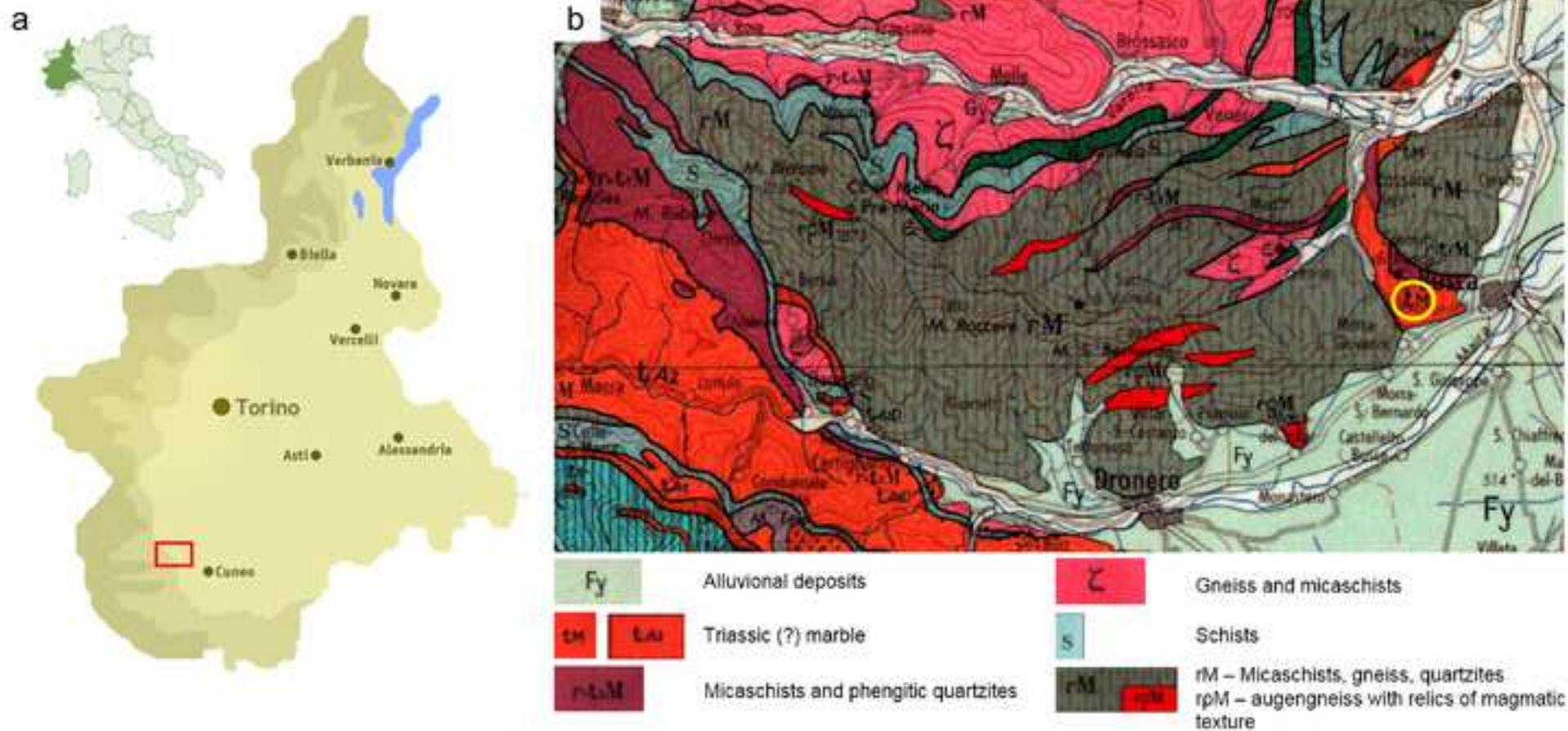
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34 **Fig. 2** a) satellite image of the quarry area. The artificial canyons are denominated with the letter C and consecutive
35 numbers from 1 to 4. b) *Busca Onyx* sample characterized by nearly parallel calcite layers, which show variable thickness

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38 **Fig. 3** Insight of canyon C4. The ground plane is artificially leveled and flattened.

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41 **Fig. 4** a) High altar of St. Filippo Neri (Turin). The Solomonian columns are carved in *Busca Onyx*. Vines made of gilded
42 bronze are applied into the spiraling cavetto of the twisting columns. b) Sarcophagus of King Carlo Alberto, Basilica of
43 Superga (Turin). *Busca Onyx* is employed in the decoration of the monument to the king and the walls of the Crypt. c)
44 Insight of St. Donato Cathedral, Mondovì (Cuneo province). Natural stone patterns are painted on stuccos. The main
45 decorative element is *Busca Onyx* imitation.

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48 **Fig 5** a) Insight of canyon C3. b) Actively growing concretion. c) *Curtains* exposed by quarry exploitation in canyon C4.
49 d) Coralloid aggregates formed by the concentric layering of calcite, canyon C3. e) Tool marks on a canyon wall.

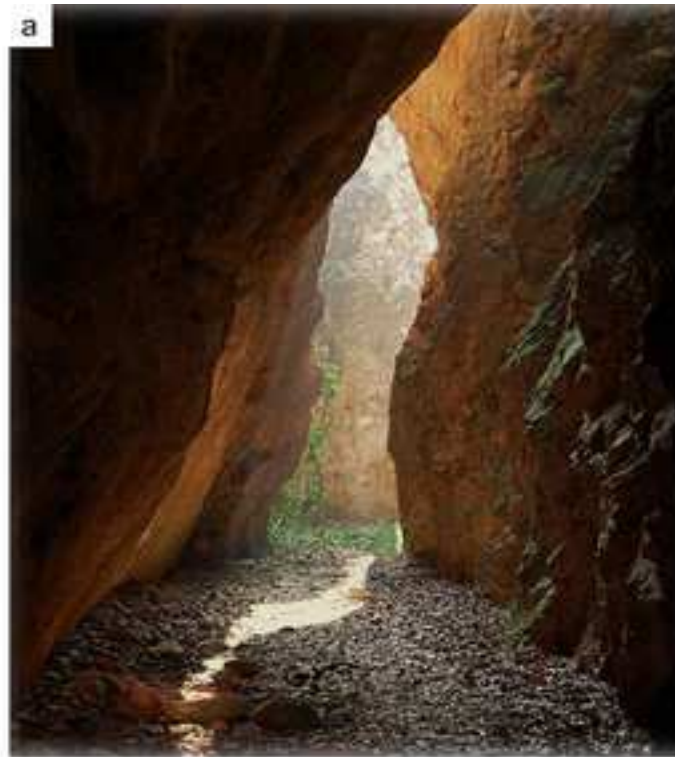
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51 **Fig. 6** The rich spontaneous vegetation colonized almost entirely the quarry area. a) Entrance of canyon C3. b) Black
52 lichens growing on a *Busca Onyx* surface.













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November 27th, 2017

To the concern of Geoheritage Editorial Board

Dear Sirs/Madams,

Please find attached the manuscript "Touristic fruition of the disused quarry of *Busca Onyx*: problematics and strategies" by Alessandra Marengo, Alessandro Borghi, Erica Bittarello and Emanuele Costa.

The paper presents the geotouristic project carried out on *Busca Onyx* quarry, in Piedmont (NW Italy). *Busca Onyx* is an ornamental stone quarried from the XVII century until the early years of 1900. Nowadays the quarry is abandoned and the site can be used for didactic and geotouristic purposes. The manuscript aims at describing the quarry area and its geological features, focusing on tourism-related issues.

We confirm that this work has not been published elsewhere nor is it currently under consideration for publication elsewhere.

Kind regards,

The Authors