

MAKING A SITE OTHERWISE INACCESSIBLE ACCESSIBLE: 3D LASER SCANNER SCANNING OF THE GROTTA DEI CERVI DI PORTO BADISCO IN OTRANTO (LE)

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Abstract – The present paper enriches the framework of knowledge about one of the most important Neolithic caves in Europe, the Grotta dei Cervi in Porto Badisco, about 8 km south of Otranto (Le) (Italy). Its location close to the bay of Porto Badisco, overlooking the Adriatic sea, has made it a safe landing place since prehistoric times, when the populations arrived from the most disparate places of the Mediterranean and when, as evidenced by archaeological research, propitiatory and initiation rites were held inside the cave complex, often referred to as the Sanctuary of Prehistory in the Mediterranean. Currently, thanks to the 3D laser scanner survey carried out in the cave, there is a complete documentation, a digital archive that collects a database from which it is possible to extrapolate data regarding the morphology of the cave complex and the spatial location, materials and deposits present. The combination of different types of relief made it possible to relate it with the external environment, with places that were once crossed by a river. Moreover, thanks to the mapping of the extraordinary corpus of pictograms, it is possible to digitally preserve the figurative apparatus, which has been and still is being studied by numerous scholars who in recent decades have tried to grasp its true symbolic meaning.

Introduction

The extensive karst system of the Grotta dei Cervi and the Cunicoli dei Diavoli represents an archaeological site of great importance as it has been frequented by the prehistoric man since the Upper Palaeolithic. It lies below the plateau close to the inlet of Porto Badisco (Otranto), the terminal portion of a paleo-riverbed called Canalone. The cave was discovered in 1970 by some members of the "Pasquale De Lorentis" speleological group from Maglie (Le) who ventured into one of the access cavities and went down for about 14 meters before reaching the first rooms. The corridors branch off in different directions and they are variously articulated and placed at different levels. On the oldest Paleolithic levels of the Grotta dei Cervi, the archaeological layers of the Neolithic (VI-IV millennium BC) and the Metal Age (late IV-III millennium BC) are embedded, when the caves were frequented for cultural purposes, initiation and funeral rites. The important and numerous pictograms of the Grotta dei Cervi date back to the Neolithic of the V-IV millennium BC: they appear from the rocky walls of Corridor 2 and they are made of red with the use of ochre and of black with the use of bat guano.

They are strongly symbolic pictograms, which have determined the name of the karst complex as "Sanctuary of prehistory in the Mediterranean". The representations on the

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Figure 1 – Porto Badisco Otranto (Le). Zenith view of the archaeological areas under study. Integrated survey with 3D laser-photogrammetric hybrid techniques of the context and of the Grotta dei Cervi (Mitello & Muscatello, 2015).

walls of the Grotta dei Cervi refer to propitiatory scenes of deer or wild boar hunting, individual or collective anthropomorphic ritual representations, initiation and religious rites. Figures of great charm but fragile as their survival is linked to the conservation of the microclimate inside the cave.

Along the corridors, at the foot of the walls with paintings, there is evidence of religious, ritual and funerary practices of the early agricultural communities of Salento and more, represented by circles of stones, with traces of hearths inside which vases have been found; these vases contained offerings to chthonic deities and to the "Mother Earth" to gain favour with agricultural crops and to win the benevolence of the gods. Some portions of the Grotta dei Cervi have been the subject of archaeological investigations between the 70s and the 80s of the last century, with excavations that have made it possible to establish that the use of the cave began before the creation of the pictograms.

As part of the project for the enhancement of the territory promoted by the Municipality of Otranto and carried out in collaboration with the Archaeological Superintendence of Puglia, in 2015 an organic and articulated survey work was started: for the first time an integrated parametric survey of the entire Corridor 2 of the Grotta dei Cervi with its representations has been created and processed in high definition color with the 3D laser scanner technology (Figg.1-6). The survey and digitization of data still aims to know and study the morphology of the cave and the pictograms it contains; a fundamental step for

digital preservation; the "*digital twin*" of the monumental cave complex can be considered as the model intended for scholars and users that allows them to see a site that would not otherwise be available for visits.

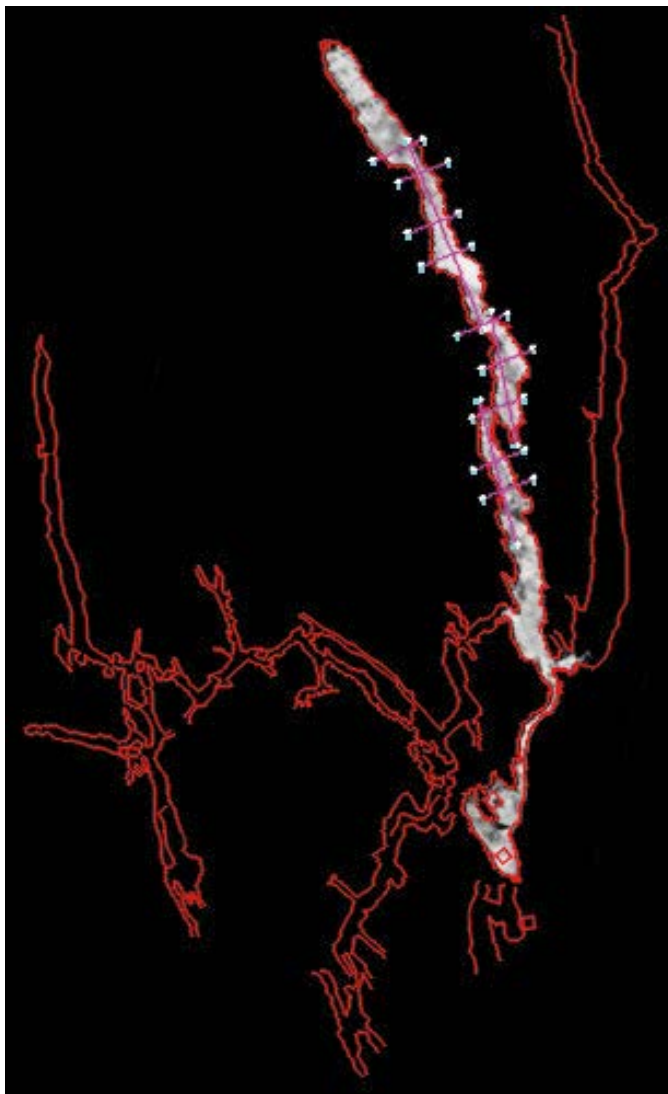
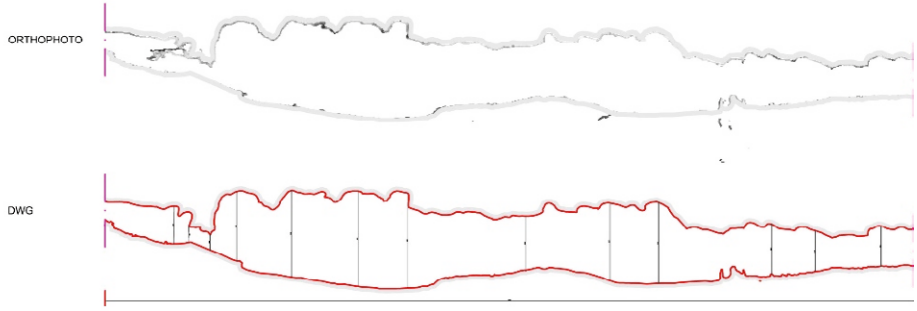
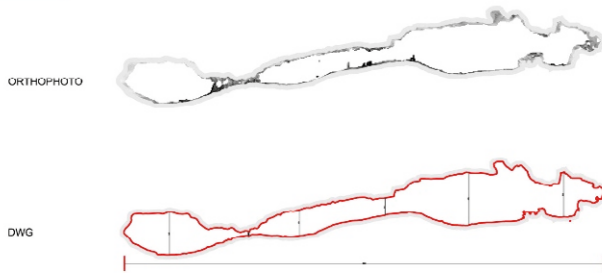


Figure 2 – Grotta dei Cervi. Relief of the rock complex. Corridor 2 detected with technologies integrated with color parametric 3D laser scanner (Mitello & Muscatello, 2015).

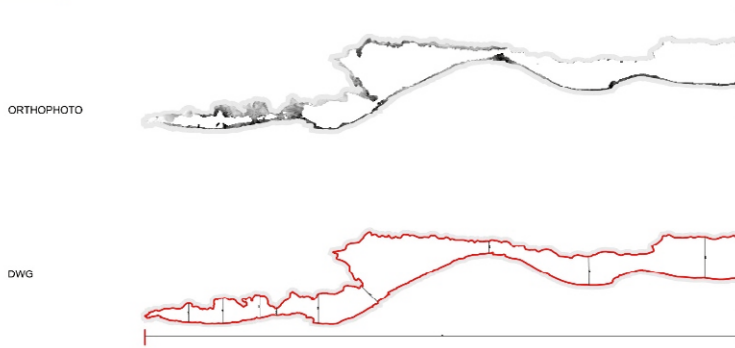
Section 9-9



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Section 11-11



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Figure 2 a – *Grotta dei Cervi*: Corridor 2 longitudinal sections.

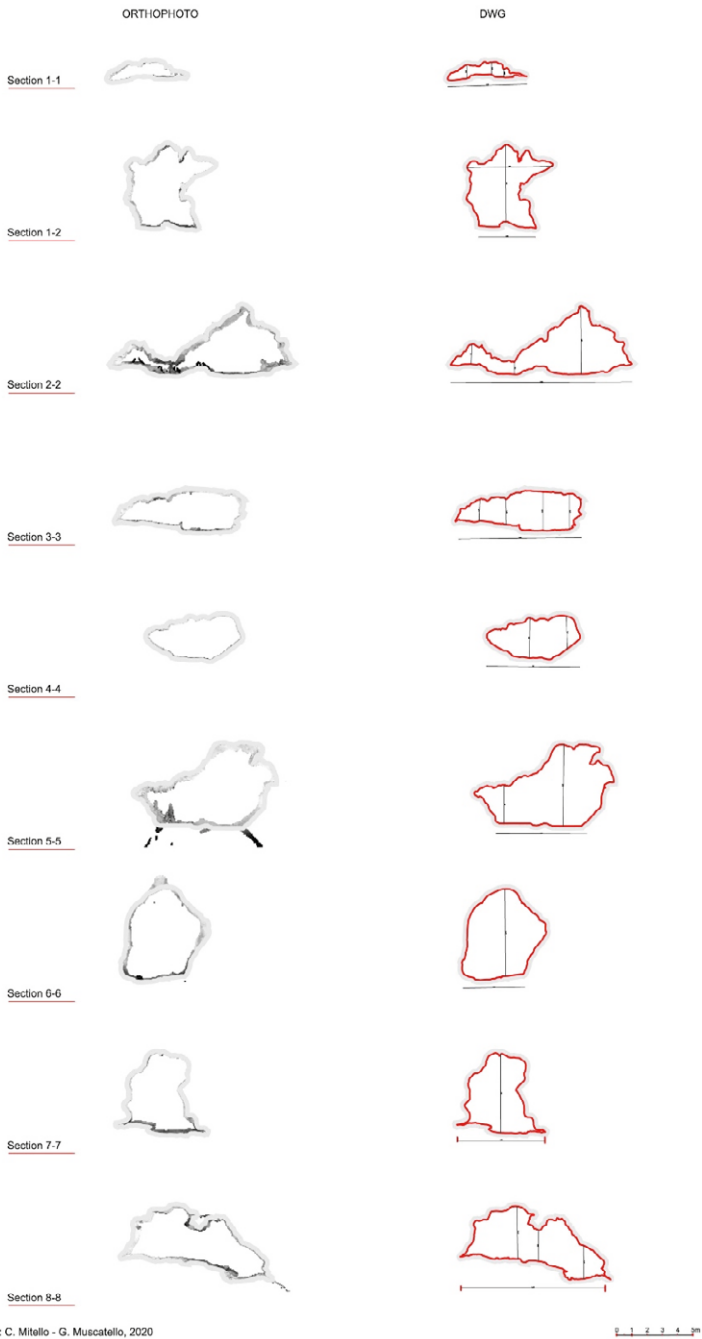


Figure 2 b – *Grotta dei Cervi*: Corridor 2 cross sections.

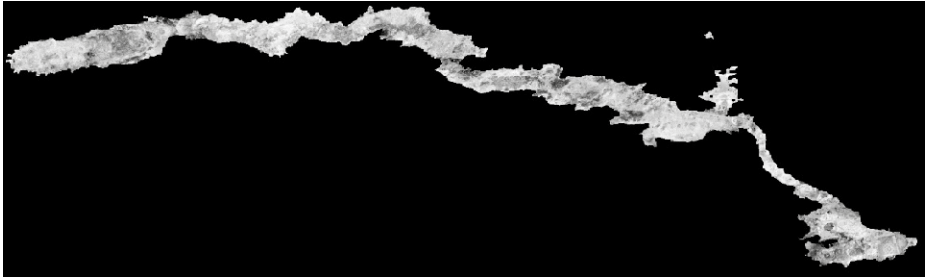


Figure 3 – Grotta dei Cervi, Corridor 2. Planimetry. 3D digital twin from dense cloud of internal volume. The morphology of the cave is highlighted (Mitello & Muscatello, 2015).

Methods: the cave and the relief as a method of knowledge.

Representing the three-dimensional space of the cave context through an overall vision was a difficult undertaking. Indeed, the cave does not constitute a single environment, it is a system that is only partially comparable to a monument or an archaeological site. Its planimetry is irregular and it is divided into rooms and alleys, where you can find distracting elements such as concretions, stalactites and stalagmites and archaeological deposits. Added to this is the irregularity of the walls, modelled in eaves and recesses, that do not allow a perfect view of the limestone surfaces. The non-conformities of the rock are constitutive elements of the painted figures; the same way, the artificial light reveals the images, giving them vibration and movement. These conditions have required a preliminary study of the context and an evaluation of the relevant procedures to be adopted.

Following the process of elaboration and creation of a dense cloud, the use of the 3D scanning technology (TLS) has offered an inspectable and measurable three-dimensional model that proposes the detected reality with a remarkable level of detail and completeness, from which it is possible to obtain not only the desired volumetric graphical representations, with global geometric information, sections and plans, but also the possibility of understanding the morphological characteristics of the site, the overall size, the abacuses of the materials, the colors and the monitoring of the cave and of the rock paintings present over the years.

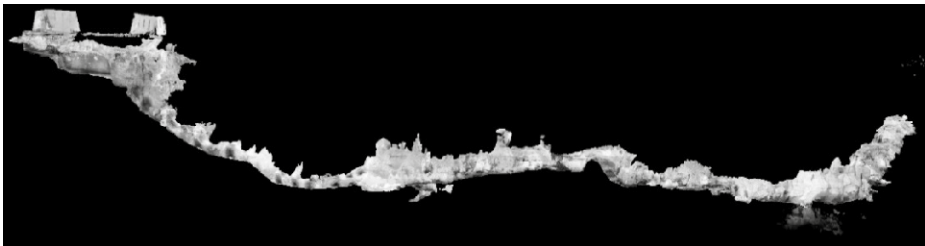


Figure 4 – Grotta dei Cervi, Corridor 2. Side view of 3D digital twin from dense cloud of internal volume. The three-dimensional model generated by the global point cloud represents the current state of the complex with all the morphological characteristics and peculiarities, including the corpus of pictograms (Mitello & Muscatello, 2015).

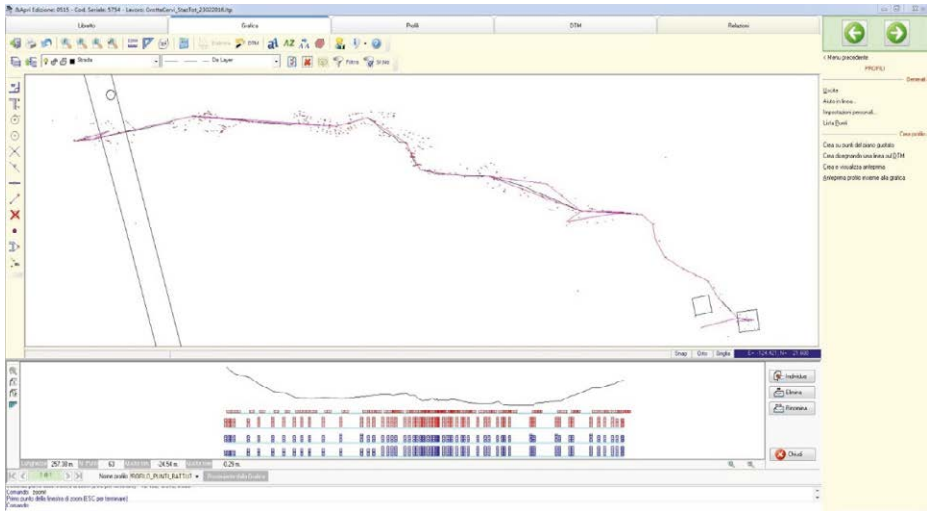


Figure 5 – Elaboration of the georeferenced integrated survey, with Gps and Total Station, of Corridor 2. Plano-altimetric development of the polygonal materialized in the cave (Mitello, 2015).

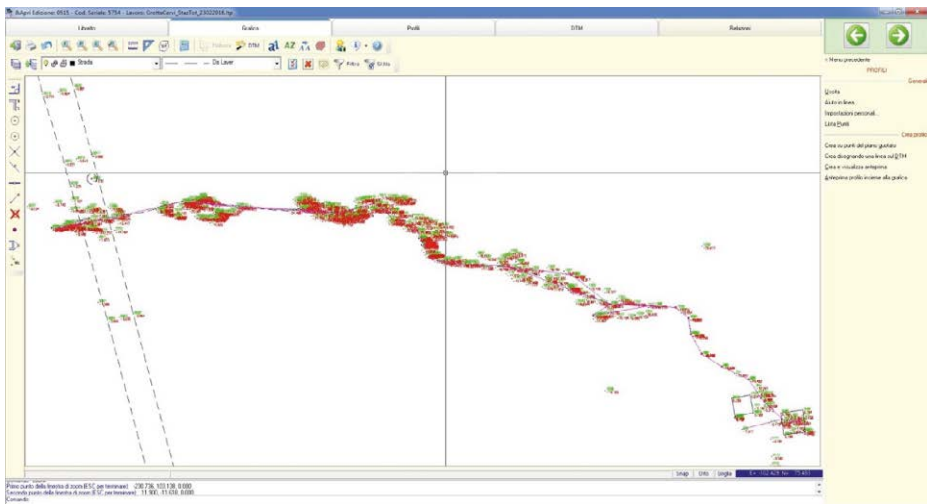


Figure 6 – Elaboration of the georeferenced integrated survey, with Gps and Total Station, of Corridor 2 of the Grotta dei Cervi. Development of the planimetric trend of the polygonal materialized in the cave (Mitello, 2015).

The laser scanner surveys in the cave, integrated with a topographic polygonal support and a GPS survey of the entire external area of Porto Badisco, made it possible to frame, reposition and orient the caves in relation to its surroundings; an important

reinterpretation of the first surveys carried out in the 1970s.

The scans, compatible with the size of the geometric shapes of the site, ensured a detailed survey and were carried out from different points of view to obtain a complete coverage of the entire structure and to avoid shadow areas or gaps characterized by lack of data. The photogrammetric mapping made it possible to add further useful information, including the color of the rocks and the pigmentation of the pictograms.

The processing of the survey, the subsequent creation of a virtual tour designed within the three-dimensional model resulting from the 3D laser scanner survey, allows you to have an integral view of the geometric and morphological components of the caves excavated by an ancient underground river and later used by the man.

Digital mapping of pictograms

The Grotta dei Cervi is one of the most important monuments of post-paleolithic wall art in the Mediterranean.

Its pictograms, as already mentioned, represent a full immersion in the messages left by the people who used it thousands of years ago. The sets of pictograms on the walls, characterized by images of considerable size, were made at different times and with different pigments including ocher, bat guano and cinnabar, present in one of the corridors.

One of the most evocative sections of Corridor 2 is represented by the last section in which a pictorial composition is presented: spiral-shaped, cruciform and anthropomorphic elements and deer hunting scenes tell a suggestive story that still poses countless questions.

The pictograms represent an enormous heritage, but due to the precarious climatic conditions within the cave, they constantly risk being erased or ruined forever together with the story they tell and their meaning that is still to be examined, which is the result of experiences and thoughts of the men who lived in the Neolithic and later, who transmitted and shared, consciously or unconsciously, their lives and their habits with their representations.

The digital mapping and the consequent cataloging made it possible to definitively record the representations to make them visible to the community and available for the study of the experts in the field, without the need to physically enter the cave (Fig. 7-10).

Conclusions

Much has been written about the Grotta dei Cervi in Porto Badisco over the years, especially about the interpretation of the pictograms and about the materials found in it. This work highlights aspects that have not been thoroughly investigated such as the morphological and dimensional conformation, and the exact spatial location of the pictograms within it.

From the analysis of the data - still in progress - resulting from the work carried out with the application of modern survey technologies, a lot of elements will emerge that will help to quantify the area and the volume of the karst system where the different environments that make up the Grotta dei Cervi system are articulated.

The development of the immersive reality, the remote disclosure, the possibility of re-proposing the site, also due to the digital twin, are the aims of a probable project of enhancement and use of the cave, to make a site accessible which otherwise would be inaccessible.

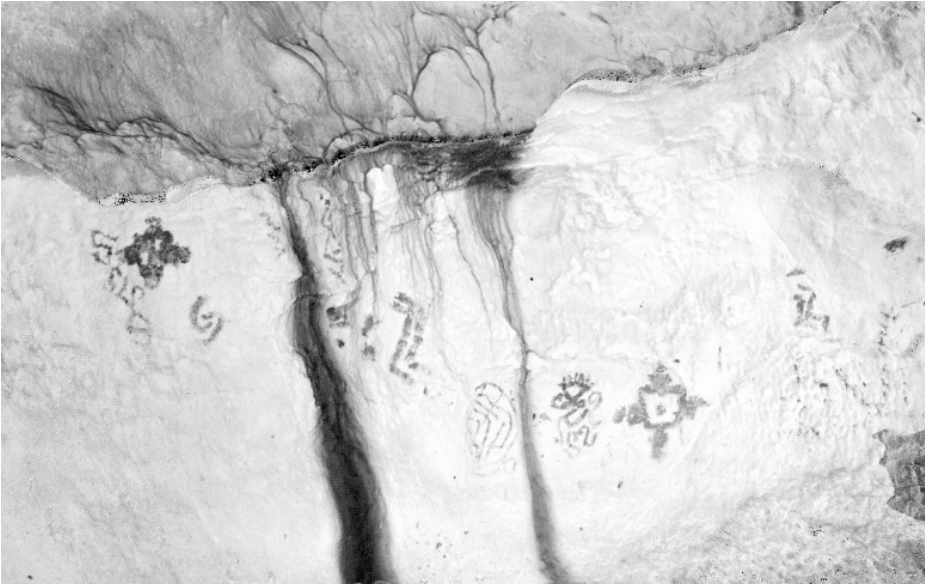


Figure 7 – Corridor 2. Digital mapping of bat guano pictograms present on the rock walls (photo by Mitello & Muscatello, 2015).

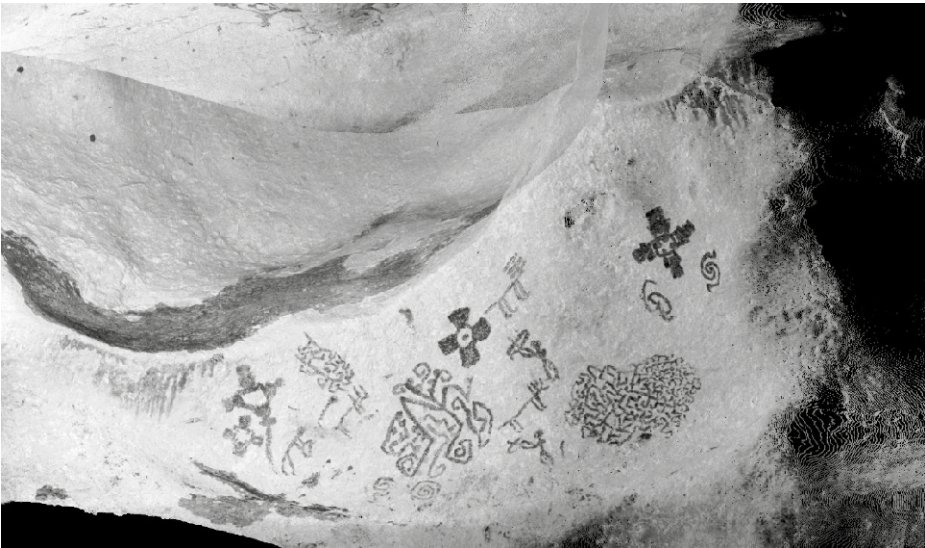


Figure 8 – Corridor 2. Digital mapping of pictograms. The symbolic representations are various, some related to the cult of Mother Earth (photo by Mitello & Muscatello, 2015).



Figure 9 –Corridor 2. Processing from 3D laser scanner survey of the panoramic views of the cave for the study and virtual use of the context (photo by Mitello & Muscatello, 2017).



Figure 10 – Panoramic view processed by the parametric survey with 3D laser scanner. The vast digital archive in possession allows the analytical study of the morphology of the cave, of the pictograms and of the deposits present (photo by Mitello & Muscatello, 2017).

Notes

The direct and instrumental surveys, the two-dimensional and three-dimensional graphic elaborations were made by Carmine Mitello and Giovanna Muscatello. All rights reserved. We thank the Municipality of Otranto and the Archaeological Superintendence of Puglia for allowing the realization of the 3D laser scanner survey inside the Grotta dei Cervi in Porto Badisco, necessary for the study of the important rock complex.

References

- [1] Bornaz L. (2004) - *La tecnica del laser scanning terrestre*. Udine.
- [2] Graziosi P. (1980) - *Le pitture preistoriche di Porto Badisco*, Istituto Italiano di Preistoria e Protostoria, Firenze.
- [3] Ingravallo E., Aprile G., Tiberi I. (2019) - *La Grotta dei Cervi e la preistoria nel Salento*, Manni Ed., San Cesario di Lecce.
- [4] Martini F., Sarti L., Visentini P., (a cura di) (2017) - *Donne Madri, Dee. Linguaggi e metafore universali dell'arte preistorica*, Catalogo della Mostra (Udine 2018), Udine.
- [5] Radina F. (2015) - *La Preistoria della Puglia. Paesaggi, uomini e tradizioni di 8000 anni fa*, Adda, Bari.