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Re-defining the relationships between the tangible and intangible heritage: the rock-cut village of Vitozza, Sorano (Tuscany, Italy)

Carmela Crescenzi[1,], Alessandro Baldacci[1]*

Abstract

In recent years, underground architectural heritage has attracted significant interest among specialists and the public. This novel empathy goes beyond the most celebrated monumental structures and is paid to magic "genius loci", to symbiotic natural and carved built environment. The awareness that small centres with few dwelling or broad underground areas should be considered a unique habitat in which natural components and human-made artefacts are part of the same cultural landscape has led us to create an original aesthetics of representation. Underground living, even in its visible romantic expression - characterised sometimes by apparently uncontrolled geometric forms- is part of a continuing process including necessary changes and adaptation to respond to the environment and social constraints. The village of Vitozza in the Sorano area in Tuscany is a significant example of this perfect integration of human habitat and environment. The tufaceous landscape stretches across a hill between two rivers and is characterised by an urban structure perfectly integrated into the environment. In this paper, the interplay between the urban form and human artefacts is described to represent the aspects that characterise living underground. In particular, we investigate the relationship between single units and their surroundings, the aspects of light and darkness and their variations according to the different seasons, and the geometrical features that generate a natural continuity between the interior and exterior. For doing so, Lidar scanning and structure from motion techniques have been used to document the site at different scales in various phases. The data collected have been analysed and represented considering human and urban scale to highlight the relationship between the tangible and intangible heritage of a complex reality that has been evolving for different centuries.

Keywords: Vitozza, Sorano, rock-cut architecture, digital photogrammetry, architecture survey.

Introduction

Geographical notes

The rupestrian settlement of Vitozza (42.678425908062486, 11.75601286843244) is one of the most important rupestrian sites in central Italy and its analysis can be profoundly significant to the contemporary idea of landscape heritage culture from both an ethical and an aesthetic point of view. It's an archaeological natural park, safeguarded and promoted by the Municipality and supported in research and development work by local and university scholars.
Vitozza has recently become a known destination for tourists; this has allowed the local population to rediscover the cultural and economic value of their landscape as a profoundly historical memory of an ancient anthropic experience immersed in a luxuriant wooded natural context of diversified biodiversity.
The rock settlement extends from the east of Sorano, the municipality it belongs to, and develops up to the slopes of a plateau overlooking the branches of the springs of the Lente stream and the confluence of the Felcetone ditch (Fosso di San Quirico).
The territory around is made up of volcanic soils: the western slope of the hill is characterized by tuffs and ignimbrites, which rises gently from the Fiora River valley up to the Volsini Mountains, the northern fringe of the volcanic cone of Lake Bolsena. In this extremely rich and complex morphology, where stream erosion shaped the volcanic ground and created deep gorges, humans have found the perfect environment to protect and live.
After going down the road to Vitozza and crossing a narrow bridge, we'll find a small road next to rocky front with few small windows and doors spread over multiple levels. In spring, when the vegetation is dense and luxuriant, these openings can be almost completely hidden and impossible to be seen, in fact the perception of the site constantly changes and evolves its colours with time.
Passed the Piancistalla area and approaching the Vitozza village, the rocks openings slightly increase in number and volume overlooking the ancient stone road where furrows traced by carts become more and more visible. After circa 1 km, perched on a rock peak, a huge masonry in cut ashlars, stands out on the crossroads and lies on the sharp brink of a steep slope, dividing the plateau of the Castle from the upper edge

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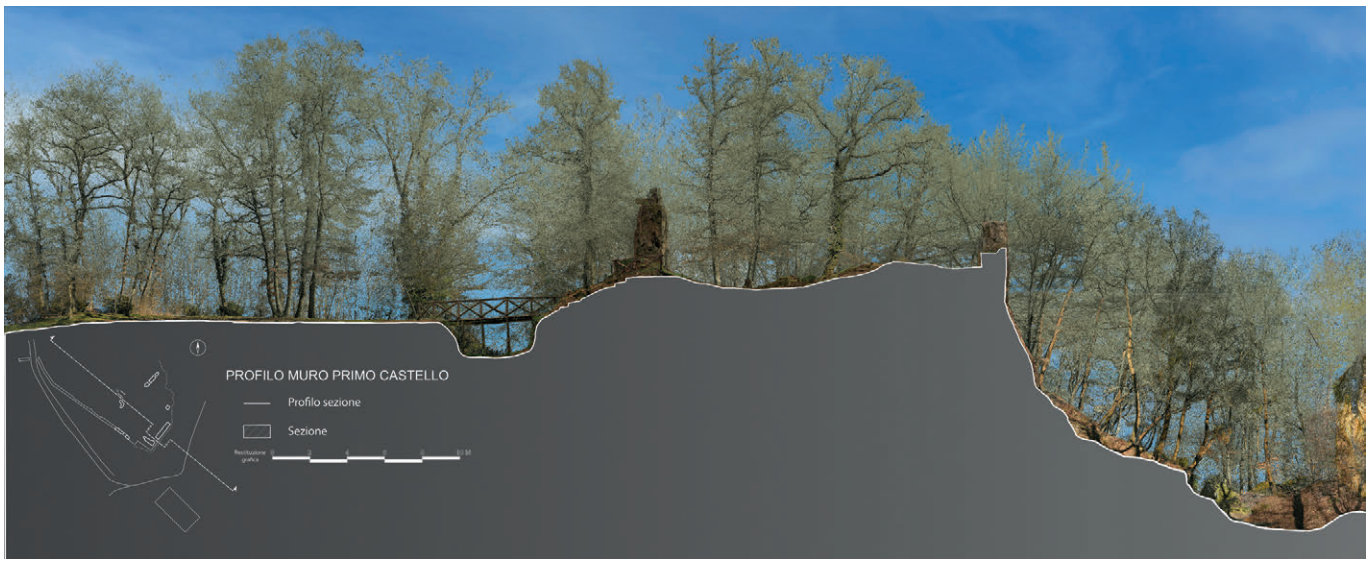

Fig. 1 – Vitozza. First Castle, Northeast Environmental Longitudinal Section. The ratio between the top of the plateau and the mid-slope route. The fortification is the first of the two fortresses that characterize the remains of the medieval castle of Vitozza. Survey 3DS L3DS Riegl-Faro. Point cloud processing, Recap pro. A.A. 2022/23 (graphics L. Giugno).

of Piancistalla and dominating the valley of the Lente and Felcetone.
This is the edge, where the ancient rock village of Vitozza begins.

Historical notes

Vitozza is one of many Tuscan rupestrian settlements, but its natural and artificial stratigraphy is more vivid and clear than other sites'; the overlap of masonry buildings, fortifications (from 12th-13th century) and Chiesaccia over the pre-existing excavated rupestrian plant is extremely fascinating and helpful for social, historical and architectural researches.
The headland (the plateau with its slopes), on which the settlement lies, is bordered to the south-east by the ruins of an ancient fortress called First Castle (fig. 1), that overlooks an artificial moat, and bordered to the north-west by a second fortress called Second Castle, protected by steep and tall rocky walls. Both strongholds dominate over artificial ditches that protect them from possible attacks from within. On the south-west front of the fortresses, fragmented traces of ancient walls descend to the valley. On the same side, the stone cart track continues the itinerary until it reaches the ruins of the third fortified pole of Sant'Angiolino.
The fortified centre served an essential strategic function in 1223, when the fortress was requested by the Orvietani family, together with the castle of Pitigliano, as a ransom for the release of the Aldobrandeschi brothers (Parenti, 1980: 21). Furthermore "The importance achieved by Vitozza, immediately after Sovana and Pitigliano, it is well documented by the recorded tithe from the years 1276-77, when the two ecclesiae of Vitozza, San Quirico and San Bartolomeo, contributed respectively of VI pounds and V pounds and X coins, way higher than the tithe of the church of Sorano and of the parish church of San Giovanni Battista in Pitigliano". (Parenti, 1980: 22).
The declining fortune of the fortified centre is attested in a 1454 document, that states, "...the Sienese army, coming from Monte Amiata, had occupied all the hills around Sorano, from the San Valentino plateau up to the place where once it was Vitozza". (Parenti, 1980: 26). During the 1455 clashes, the Orsini family defeated the Sienese army and reoccupied Vitozza. However, they did not restore the original fortification, so that the population, that had abandoned it during the Sienese occupation, did not return to Vitozza (Biondi 1988: p. 27).
The ancient attendance of the site is testified by ceramic fragments from the protohistoric era and some lithic materials from the neo-Neolithic.
The structure of the medieval settlement is still easily distinguishable despite many collapses of the rocky fronts over the centuries, when the constant care and maintenance of its original inhabitants has given way to complete abandonment. Indeed, only recently the local administration tried to rearrange this ancient and precious site in order to transform it in an open-air archaeological park.
Unlike the ruined masonry constructions, some populations lived in the caves of Vitozza at least until the second half of the eighteenth century, as attested by the estimates, around 1783.

The cave village

Urban characterisation

At the foot of the fortress, little paths branch off directed to the original village centres, which are locat-

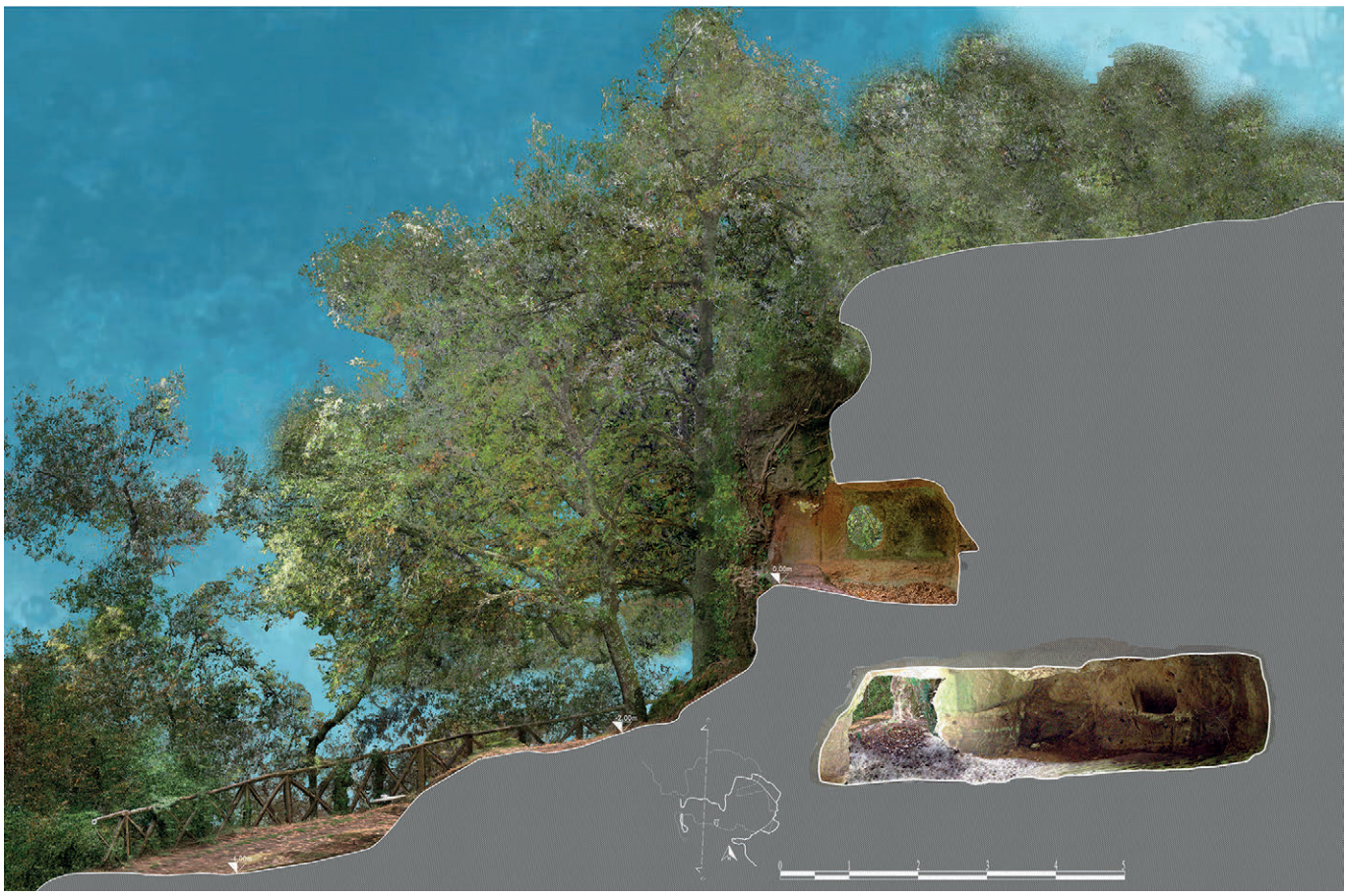

Fig. 2 – Vitozza. Environment Section. On the top is Cave 24, a south-southwest opening with a slight west window controlling the route; under Cave 25, with a southwest entrance. A.A. 2019/20 (graphics C. G. Manzo).

ed on the opposite southwest and northwest sides. On the southwest route, less than 100 Mt away, a wide road branches off leading up to the plateau where a rounded arch introduces the fortified village.
The path that runs SW had protective walls: we can still find small traces of this boundary on the scarp, as mentioned above. The access from the road to the plateau for loads and livestock was guaranteed by some cut caves, of which a notable example is located immediately after cave 31 and between caves 30 and 29 and perhaps even between caves 13 and 12. These passages were clearly created by cutting some caves, suggesting that the rock settlement existed way before the construction of the two forts. Almost all the caves (Parenti, 1980: planimetry) look onto the same stretch of slopes (the first castle and the cut after the church), both those facing SW and those facing NE, share the same typological characteristics and features.
The stone track serves the caves, which are arranged on two or three levels connected with narrow staircases leading to the plateau. (fig 2)Part of these connections is not fully accessible nowadays because climbing plants and undergrowth vegetation created an accessible hurdle covering them entirely.
The two upper levels of this caves' series probably constituted a nucleus exclusively intended for housing and storage purposes, because their arrangement full of niches, basins and various shelves made them suitable for collecting water, plus their height made them impossible to be reached by large animals.
Although not being easily accessible, we can find some others small openings downstream of the route.
Multi-level caves with internal connections are very rare, but there may be others still hidden because the archaeological complex has not yet been fully excavated.The only "duplex" unit which is well preserved and open to visitors is cave 22, consisting of two rooms whose internal connection is perhaps later than the caves' period (Parenti 1980: p. 60). There are also other examples, such as cave 20, where at the bottom of the left-hand compartment nowadays almost completely closed off, there is access to two entrance caves located at a lower level. In fact the largely collapsed caves on the right of cave 34 may have originally been a two-storey cave.

Typology of the caves

While considering remarkable difficulty in finding common cataloguing, Roberto Parenti (1980: 42 - 44) classifies the caves according to the characteristics of the openings and the furnishings they have inside; he also reports the impossibility of dating the excavations

according "normal surveys tools and paths". With almost zero reliable data on the excavation chronology and on the original destination, and without any reliable information on the excavation methods and tools, Parenti based his analytical outline to differentiate the excavation dates between two groups of caves, on comparisons and empirical assumptions. Through a direct comparison with the caves of Castel Prociano, he dates the first group (the most recent one) between 1000 and 1200 AD.
According to Parenti, the first group of caves is characterized by rectangular or quadrangular openings, they have a roughly regular floor plan and usually a chimney flue next to the door. These caves open onto the stretch of the settlement to the southwest, between the first fortress and the central church.
The caves on the NE side date from the same period and their main trait is having a quite regular rectangular floor plan. We can focus on a group of caves, located immediately below the plateau, that are characterized by an area partially block by the rock walls, located in front of the entrance. On these battlements that follow the natural course of the rock, some wooden were originally built. In Parenti's filing, the area in front is called "dromos", but only in a few cases we find cut accesses next to these spaces, which perhaps served for accessing and counting animals (fig. 3).
In the same spot, some of the caves have a perfectly rectangular opening in the ceiling, generally covered with squared blocks of tufa, which perhaps was the entrance to the passage corresponding to the masonry houses on the plateau. An example of this type of cave is Cave 57 (fig. 3).
On this side of the hill, there's a more significant number of caves showing equipment for sheltering animals than on this other side: these caves are equipped with feeders for large animals with through holes dug into the tuff, plus troughs and niches for sheltering small animals.
The second group of caves, the most ancient one, includes a particular typology, especially in Vitozza, that is characterized by an archivolt opening and a roughly circular sector in plan with a dividing septum in the tuff.
Parenti hypothesizes that the planimetric tracing was obtained with the guidance of a rope passing through the entrance and the corner of the internal wall.
The cave was thus divided into two parts: the scholar expounds that room between the two with more regular walls was more suitable for accommodating bed shelves, while the other one with a rounded volume was used as an animal shelter with equipment for feeding troughs. While sharing with Parenti's hypothesis the idea of tracing the planimetric control of the rooms with the help of the rope, we believe that the different conformation could be due to the subsequent adaptation of the room from being a house to a small stable.
According to Parenti, the factors that suggest an archaic bicellular typology are the formal analogy of the archivolted opening of the caves and the existing columbarium on the north-west side of the headland, the presence of cut caves upstream of caves 29 and 30, and again the lack of a close relationship between the masonry structures and the distribution of these caves on both sides of the slope. We deem Parenti's analysis on the archaic nature of the village acceptable considering only the fortification of the cape and not its subdivision among the caves.
Next to the septum caves, there are some single-celled caves of different sizes, of which a conceivable interpretation can be that those were the outbuildings serving the houses. An overall analysis of urban nature could lead to new deductions on the relationships of aggregations and family dwellings.
Furthermore, we should consider in our analysis that, on the NW front, there's a series of caves, not surveyed by Parenti, which had the collecting rainwater from the plateau. These are the caves placed at the end of the steps between caves 18 and 19 (fig.4), the cave 27 that is unicellular, the adjoining and intercommunicating room with cave 70 and reachable by a ladder from the plateau and two other caves between the n° 70 and the cut out near n° 32. They have a water collecting system dug into the stone wall and various tanks for decanting the collected water.

Survey and representation on the vitozza castle cultural rock landscape

State of art

There are various techniques for the representation of rock environments because of the diversified subjects of scholars' specific interests and the surveyor's level of technical capabilities, plus the amount of time available for surveying. In any case, the request of all scholars is creating graphic documents that allow recognizing, in a scale survey, the furnishings that characterize them (Dalmiglio 2020: p. 24) and finding the clearest and most intuitive way possible the detectors can communicate not only the results of their study but also the physical perceptions of the site.
The archaeological interpretations of Vitozza are still based on the archaeological research of Parenti R. (1980), plus the additions of Boldrini E. and De Luca D. (1988) on the historical study of Biondi A. (1988) and some other very few scholars of the last century.
The graphic representations in Parenti's volume are vivid and linear, with a surprising restitution and excellent legibility, but its drawings are limited to planimetric sections of the excavated artefacts only. The floor plans from his publication are a synthetic result of many images, eidotypes and metric data collected through traditional tools and methods together with many physical limits and dangers. However, this graphic way of representation conceptually removes the excavated units of the settlement from their physical environment. Therefore, the planimetry lose all the references and connections with the outdoor natural morphology.

Fig. 3 – North-east glacis. Plant caves 55/57. Sections of cave 57. On the northwest wall of Cave 57, we find a cross with a calvary almost the entire wall. SFM, processing Metashape Pro. A.A. 2022/23 (graphics E. Zaka, G. Valdinoci).

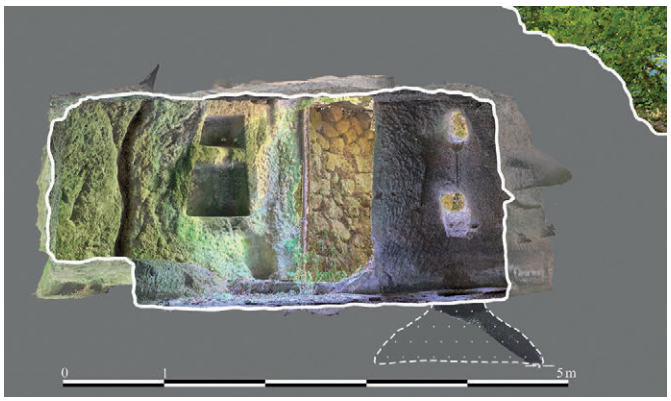

Fig. 4 – On the cave walls, there are furrows to collect infiltration water, structures for settling and tanks for accumulation. A.A. 2021/22 (graphics A. Picci).

Boldrini E. and De Luca D. redrew some of the caves already present in Parenti's survey. They added some axonometric drawings, of which one dedicated to Cave 15. Furthermore, they integrated the existing data with the unpublished documentation of the caves from 70 to 73 (Boldrini 1988: 39-45) and with an archaeological investigation on the covers of the same caves. The description is entrusted to spare floor plants and section profiles and only in the upper archaeological area we can find a real planimetry and some graphic attempt to properly depict the rocky shape of the hill and to contextualize the artefacts excavated on the top of it.

Heritage and Education

The survey campaigns involve academic seminars and laboratory activities, integrating with multiple researches and teachings. These are the basis of an educational project focused on the knowledge, enhancement and promotion of the historical and cultural heritage. It integrates technical and technological skills with a purpose of a numerical discretion of the site and in order to promote a careful investigation of its cultural signs.
The project aims to activate a cognitive circuit that develops different skills suitable for different topics, such as:
- The identification of the close relationship between tangible and intangible elements of the territory and its physical and emotional elements.
- The training of scholars and professionals capable of discovering and revealing the contents of a cultural landscape.
It is an intrinsic process that the enhancement of the intangible cultural heritage, in terms of traditional knowledge, through the reinterpretation of the tangible, heavily stimulates curiosity and creativity in various training and design methods. (Trocchinesi, 2017:3)
The surveys with a lifespan of many seasons and years, have helped to grasp unusual and hidden aspects in the context of architectural documentation and to focus more on topics like the landscape's aesthetics principles and the intangible value of the influence on human feeling. A subsequent dimension is the enhancement of the tangible through the intangible and vice versa.
In an archaeological landscape context, there are many cultural elements, of which the general public almost never reach a fully understanding of its value and its narrative significance. We must support the direct use of the tangible asset with a proper narration extracted from deep and complete knowledge, in our case study, of each excavated unit, of its nuclei, their development and degradation. At the same time, it's essential to leverage the intangible value of the asset itself to involve the users even more.

Data representation

The rock habitats survey springs a vast and endless multidisciplinary skills process.
The innovative techniques for the survey of the territory and its architecture, through digital photogrammetry (Gaiani, 2017) and laser scanner surveying methods, let the researchers to reveal not only the morphological aspects of the "real form" but also to compare and fully analyse the collected data, in order to evaluate the formal appearances of use and the quality of life, seeking builders' technical skills by subtraction.
For example, one of the aspects to be evaluated is the quality of the sunshine lighting in the rooms (Assimakopoulou, 2012:109-113) and the cultural astronomical level of knowledges the builders had during the designing and construction processes.
The planimetry being controlled and measured by a rope, as Parenti hypothesizes, also suggests a possible control depth and width of the units and their relationship with the opening in order to achieve a sufficient contribution of solar lighting. (fig.5)
From this ongoing study, the arrangement of the openings, the trapezoidal plan, especially in the caves with a septum, and the depth of the rooms, where alterations were very few, directly respond to bio-climate criteria.
Following the orientation of the rampart and its sides, the openings are mainly oriented to the southwest and in few cases, to the south, of which many units have small overlooking the west side.
The three-dimensional models from laser scanners and three-dimensional photogrammetry support continuous and interdisciplinary hermeneutical research. The models provide specific cognitive contributions and allow to create innovative and unusual analyses for these specific environments.
The interdisciplinary questions posed to the models, the exchanges and comparisons of opinions, suggests new research paths, which can be conducted on the same models in situ or even remotely. Thus, we have a continuous and seamless interactivity between the

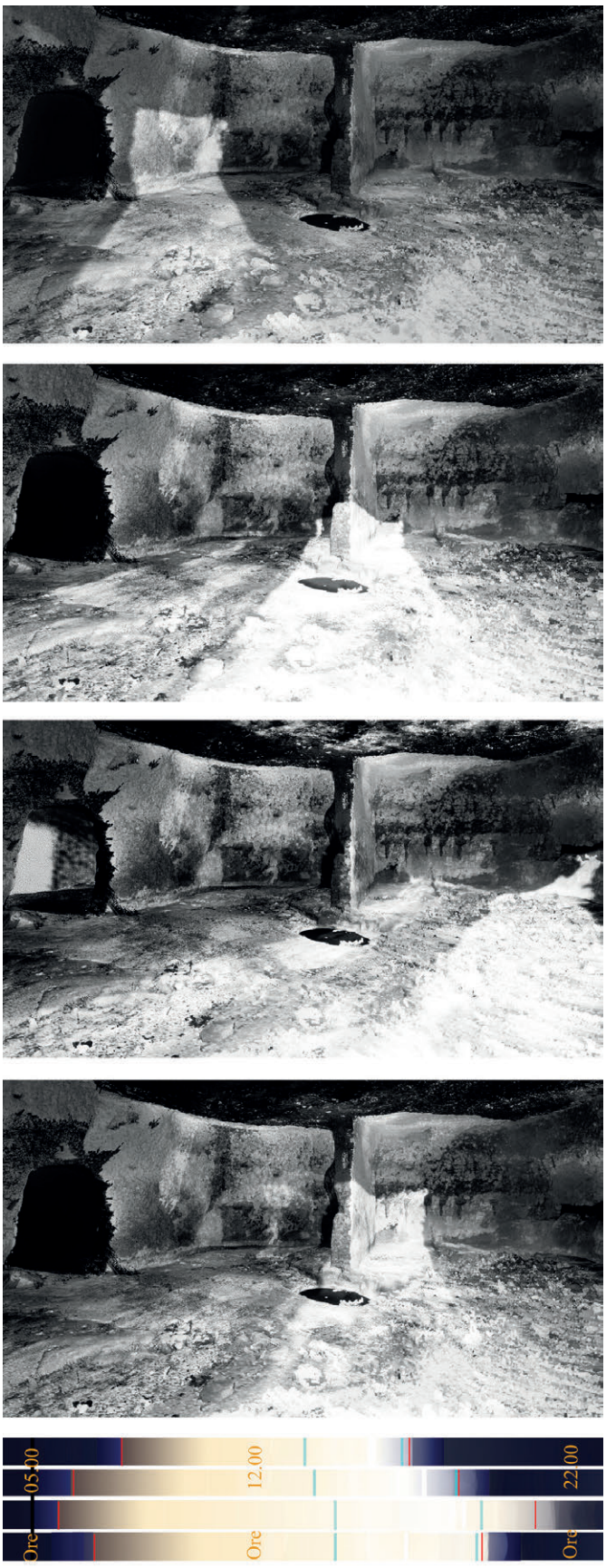

Fig. 5 – Southwest side. Cave 27, type with tuff septum. Study of sunshine. Point of maximum entry of direct light, in order, from the winter solstice to the autumn equinox. The graph summarizes the trend over the four days under review. A.A. 2022/23 (graphics E. Pieroni and F. Sini).

data translation and the intuitions, insights and integration of studies.
The digital model, consisting of extensive external and internal data, recreates a measured frame of the relationship between the natural habitat of the extrados and the artificial intrados. It allows us to quickly and easily visualize the complexity of the rocky scenery's aesthetics.
The representation of the relations between the artificial part and the whole natural complex together with a convincing visual development of them, is a central research topic of various authors.
The researchers integrate traditional and innovative techniques (Crescenzi 2016-2023), introduce classified chromatic codes (Colonnese et al, 2016), third-dimensional information from central contour lines, and their insertion in the photogrammetric context (fig. 6), and they introduce the aesthetic interpretation of the natural context of the landscape (fig. 8).

Digital survey

The studies carried out by the DIDA Laboratory researchers are based on a digital survey using three-dimensional photogrammetry and lidar technique (Light Detection and Ranging), suited for a complete documentation of the natural rocky structure of the thematic context. (Crescenzi 2020). We conducted the survey campaign over several years with different instruments and operators. Therefore, the data documentation and the caves' graphic rendering are not homogeneous. However, the lack of homogeneity of the recollected data has stimulated new visual solutions to enhance the cultural heritage's value of the sites.
The investigations, carried out between 2014 and 2018, involved the use of three leading 3D laser scanners. We obtained black-and-white architectural and landscape scans through Faro Focus Cam/2 and Z+F 5006h. Moreover, with a long-range unit Riegl VZ400 (2014), we have detected the path along the southwest coast and the Castle in colour. Then, from 2019 to 2022, we used Faro Focus S 70 in HDR for the architectural and environmental survey in colour.
Merging the environmental and architectural scans into a single unified model required painstaking and long post-processing work in order to align and aggregate all the collected data. The survey of the road has been our backbone pivot for the insert of all the architectural units' network. The enormous size of area, changing environmental conditions and the rough morphology of the rock necessarily required the temporary use of natural and movable marker. The correct continuity of the spaces was ensured by overlapping the detection areas. Subdivided by settlement unit, integrated models have been developed and elaborated with specific target systems linked to natural points. In order to avoid misalignment cases and create an organic and detailed vision of landscape and architecture, we recorded every scan with large overlapping areas.

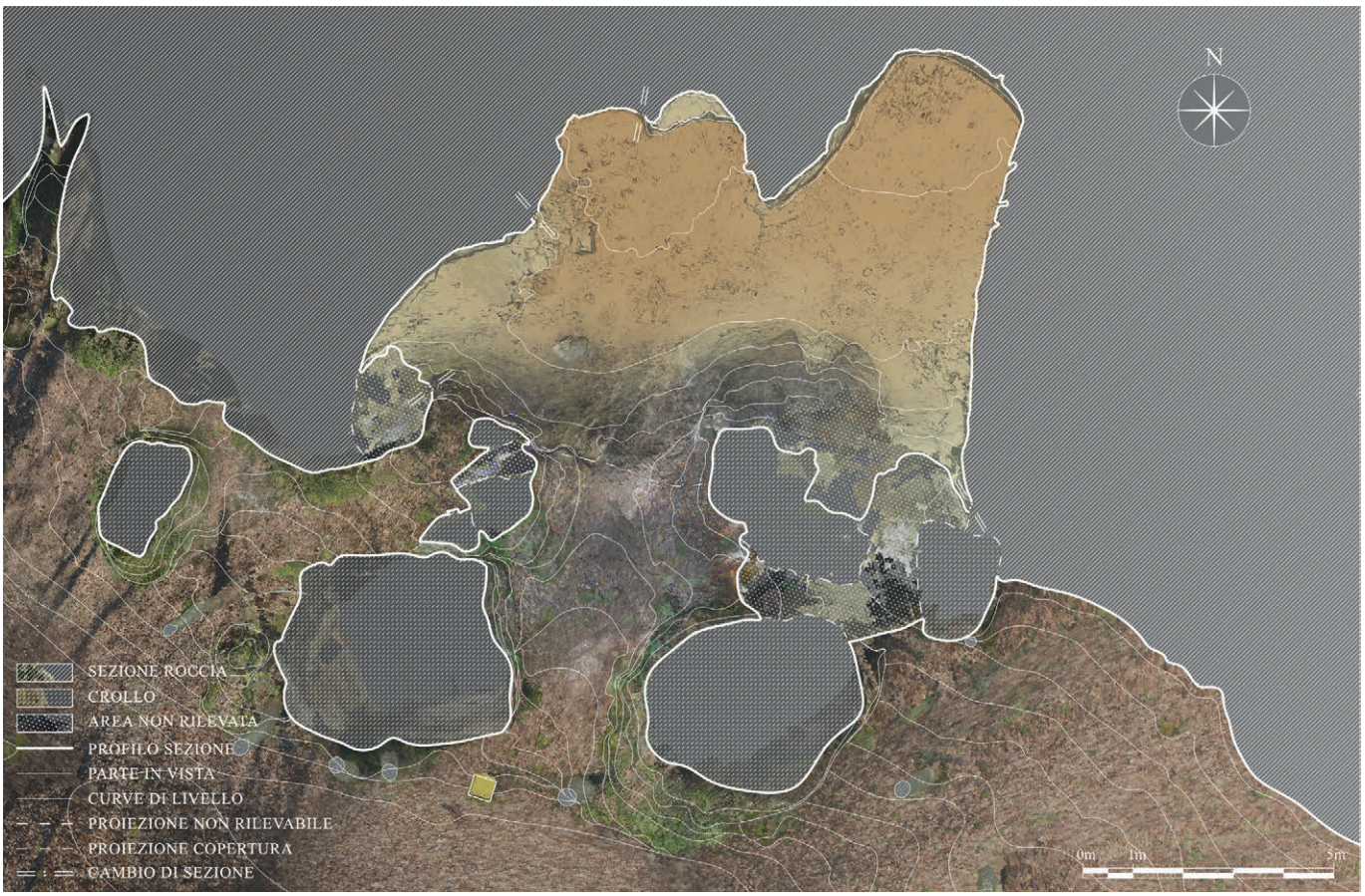

Fig. 6 – Cave 13. The contour lines, integrated with the orthophotos, facilitate the reading of the morphology of the surfaces. A.A. 2019/20 (graphics A. Smeraldi).

Fig. 7 – Cave 17. The sections carried out for each wall front are reversed concerning the plan to allow a comparative reading of the series of holes and simplify the comprehension and interpretation of the data. Photogrammetric rendering in Metashape Pro. A.A. 2019/20 (graphics B. J. Snickars).

In the first phase of the work, the data were processed by using Cyclon 6 together with Riegel, a specific program for landscape modelling. Since 2019, the software we have used for the point clouds' general management and alignment process is Recap Pro 20/22. Alignment is precise, easy and quite fast. If the operators insert the scans strictly in chronological and linear succession, the program automatically identifies and aligns them with a correct and sufficient overlapping data and non-discordant light factors. On the contrary a manual intervention is essential when files have narrow overlap, burnt data, overexposed or underexposed lights factors, such as with scans between internal and external spaces.

We also used the software Recap to obtain extensive ortho images, setting the same export factors for each scan with different pixel size. Then, using raster processing programs, we overlapped and integrated the parts by homogenizing their colour. The challenging part of this work has been integrating scans and images taken in different hours, seasons and years and still reaching an overall faithful visual rendering of the site.

The black and white laser data have been combined with the colour ones with appropriate chromatic balancing treatment (fig. 6). All the gaps from laser scans' 3d model have been digitally filled and harmonised with the photogrammetric images' mosaic and vice versa.

The interpretation of a rocky cultural landscape in a complex archaeological context requires a multidisciplinary choral research study, based on both oral and written sources, material and spiritual symbols and traditions, always following codified scientific meth-

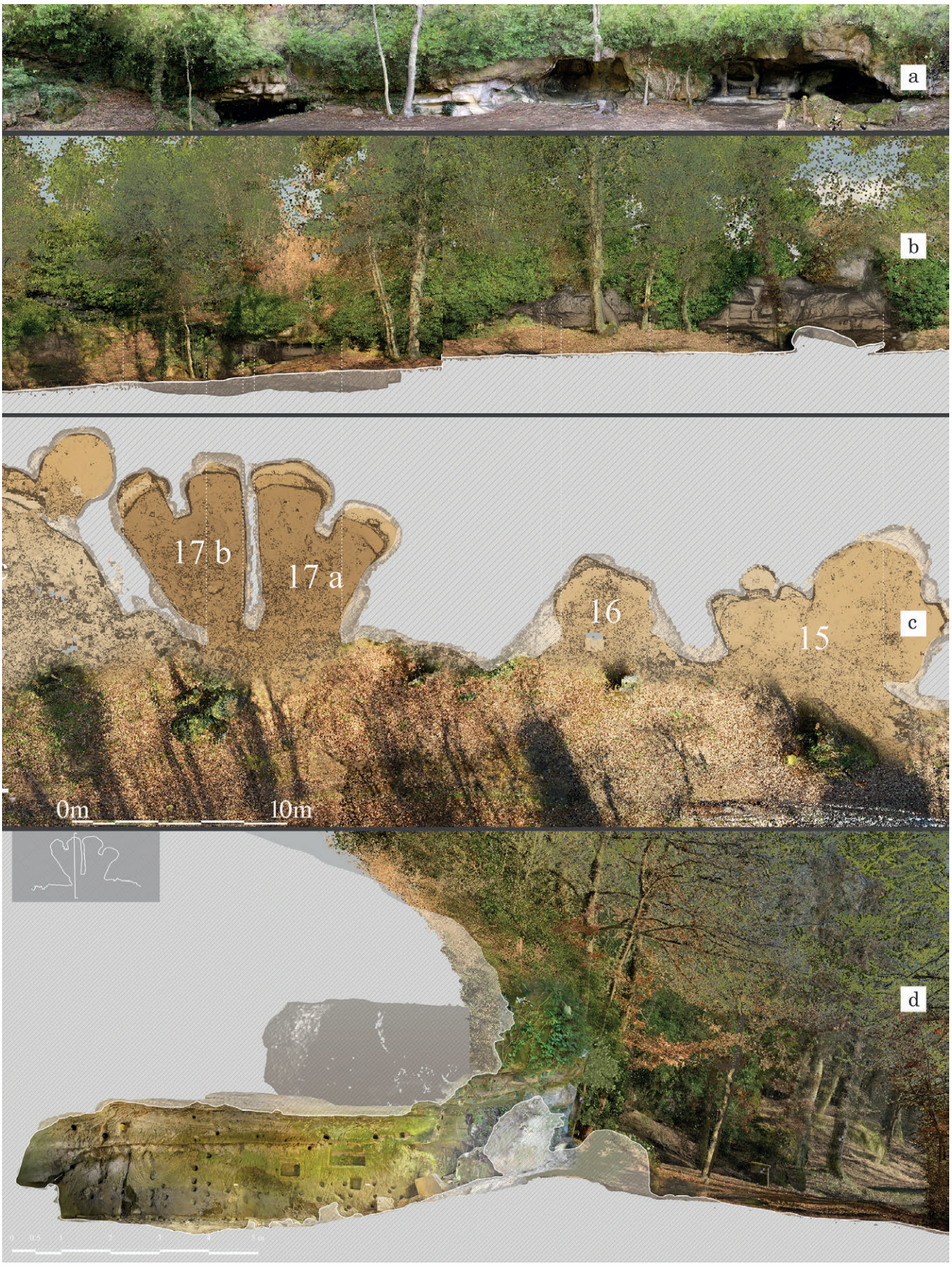

Fig. 8 – a) Prospectus in SFM, processed with Metashape Pro. A.A. 2021/22 (graphics S. Leone, D. Santini, E. Vergari); b), c) survey with Riegel, and zf. The colour data are integrated with those in black and white, treated with different pigmentation. A.A. 2019/20 (graphics B. J. Snickars); d) environmental section, integrating Riegl data with SFM processing in Metashape Pro. A.A. 2019/20 (graphics B. J. Snickars).

ods. Anyway, the most important document or record is the monument itself: its text is made of traces and signs and it's up to us to read and codify them. The interdisciplinary studies on interpretation and communication of the site require comprehensive and extensive documentation, innovative 3d modelling representation of the artefacts and consolidated Monge representation methods (fig. 7). Researches and studies on rock sites open new questions about the limits of existing tools and new integrated methodologies in order to better investigate the urban structure and the connections of architectural community aggregations though centuries.
Decorations, like the stringcourses or frames in some of the first caves we analysed, show a universal human desire to embellish and elevate the aesthetics' quality of the functional features of its residential space.
A meticulous analysis of every decorative or structural detail, extended to all the structures, is the key to fully understand this natural-urban landscape. Above all, the scientific and rigorous study of sunlight proved to be incredible useful: in fact, its application on the housing units (caves 26-27 a-b, 28, 29) showed us that, despite covering the same amount of space with a similar arrangement of the openings, the quantity and quality of sunlight is different and that determined the function of every room.
A subsequent in-depth analysis would enlarge and improve this typological taxonomic research of the archaeological park of Vitozza.

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Credits

The graphic restitution of the data was carried out in the Architecture Degree Course, Architectural Survey Laboratory, course C.

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