Cities in Evolution. Diachronic Transformations of Urban and Rural Settlements, III

VIII AACCP Symposium, Proceedings

Edited by E. Çiçek, Ö. Özkuvancı and A. Camiz

Dynamic Research on Urban Morphology books - 5

CITIES IN EVOLUTION
DIACHRONIC TRANSFORMATIONS OF URBAN AND RURAL SETTLEMENTS
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VIII AACCP (Architecture, Archaeology and Contemporary City Planning) symposium, Istanbul 2021

Edited by

Ezgi Çiçek, Özge Özkuvancı and Alessandro Camiz

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Table of Contents

The evolution of the war and the evolution of the place: fortifications across time and landscape

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Abstract

Human settlements often manifest two main needs: living in the best comfortable way and living in the safer possible way. Building and planning made outside of these two basic concepts start being frequent only when the need for "being in a place" becomes stronger than the practical exploitation of the landscape resources. The extended system of fortifications all around the Mediterranean area and in general worldwide shows an imposing approach in territorial management and defence. Knowledge of the territory has always been the basis for design, geology and geomorphology are elements that man has always considered. The landscape transformation is an element that men have to consider, but the time of these transformations is quite different from the human in military transformations, but one is strictly merged with the other. The rules guiding interventions changed continuously, in the beginning, geology and geomorphology were the first resources. Natural or excavated caves and tunnels were the first ideas allowing a safe hiding place, and somewhere to trap the enemy. When better construction technologies became available, the walls and fortresses evolved from wooden to stone solutions or passing from structures aimed to keep at bay infantry and attacking machines (catapults, rams, movable towers) to systems thought to protect from cannons and to use them to shoot at the attackers. After the invention and refinement of air warfare, the present evolution made it preferable to hide in structures completely underground or organized beneath large concrete shields with mimetic options. In a certain way, the fortifications seem to complete a long parabolic path, from the underground rupestrian refuge to the underground anti-nuclear facility. At the point of inversion, we can register a change in the use of natural landscape: geology is no more a limit for the project but rather a characteristic of the territory to be taken into consideration for the effectiveness of the result. The rules and choices in planning in different places were guided by fundamental options: the geology and geomorphology directly influenced the results of unconquerable citadels and the following aspect of the growing town. The genesis of the place and the development of human skills combine in a unique history that highlights the interaction between humanity and landscape. In the contribution proposed here, a selection of defensive architectures across time will be analysed in a series of reflections about the continuous balance between geology and geomorphology, human choices, practical and military purposes and the following influences on urban development.

Introduction: human settlements and geological aspects

Retrieving the interdisciplinarity in the scientific investigation of the territory, integrating contributions from geology, geomorphology and hydrology in the landscape interpretation process means understanding that all anthropic uses, from living to individual functional specialisations, interact with three-dimensional reality. Both the depth of the soil and the aerial layer is an integral part of the territory and participate in its continuous transformation.
The study of the dynamics that contributed to the creation of the landscape recovers the "depth" by highlighting the relationships between geology, the natural vocation of the territory, as it is objectively and as it is interpreted by humanity and its intrinsic ability to regenerate and sustain itself over time. This also allows an understanding of how the architectural heritage of a tower along the coast or controlling an inland area, of a church built on cliffs, or the old walls of a town is always integrated as a unicum with the complex system of the landscape.
The geomorphological analysis contributes to achieving a twofold objective: on the one hand, it re-establishes a multidisciplinary and cross-scale design approach attentive to the natural dynamics of the territory; on the other hand, the identification of the structural reasons and their evolutionary processes as elements constituting the natural identity of the place allows to evaluate the potential and limits of the

landscape in any environment and to identify the residual resilient capacity of these resources, elements which constitute the essential documentary basis for proposing a project for the redevelopment of valuable, but often neglected, Built Heritage elements.
In the following paper, a series of brief case studies are the occasion for tracing the genesis of different places and interpreting the contribution of human skills in defining a unique history that highlights the interaction between humanity and landscape. A selection of defensive architectures across time will be analysed in a series of reflections about the continuous balance between geology and geomorphology, human choices, and practical, architectural, structural, and military aims.

Case Study 1: the fortress in Populonia, Tuscany, Italy

Populonia is mostly documented and studied for its importance as an Etruscan civilization's settlement (Beni, 2009). Many archaeological studies have focused on the town of that period, the necropolis and the significant findings all around the excavated sites. The following developments of the town, in the Roman, Medieval and other phases seem a little neglected, thus the main landmark in the area is represented by the fortress itself, a bold and robust architecture on the top of the main cliff, dominating the gulf, probably connected to the control of the coastal routes (Casini, 2008). The "Rocca di Populonia" started its construction around the XIVth century. Its architectural organisation started from the central tower, with the following walls and later integration of the semi-cylindrical bastion in the XVth century. The whole structure uses local materials and exploits the cliffs, adapting the walls of the perimeter to the natural shape of the rocks. The urban area nearby has even more interesting uses of the original soil, with the cliffs flattened or cut to serve directly as the floor for some streets.

Geology Aspects

From a geological point of view, the Archaeological Park of Baratti and Populonia is dominated by the *Macigno* (Sandstone) and *Panchina* (Sandstone Bed) formations, two sedimentary rocks formed about 20 million and 120,000 years ago respectively. Both are typical of marine environments, but while the first has been laid in deep sea areas, relatively distant from the coast, the second represents shallow coastal sea sediment. *Panchina* rock is composed by calcarenitic levels that were formed by cementing the beach sands thanks to the presence of an abundant carbonate fraction totally of bioclastic origin and to the circulation of rainwater. Calcarenites are often associated with lenses of incoherent sands which represent the original sediment not affected by the circulation of rainwater.
The *Macigno* sandstone is the most representative stone formation in the area. It consists of a succession of layers of sandstone with grain size ranging from fine to coarse, in benches of varying thickness (from decimetres to one meter) of grey to light brown to yellowish. Layers of sandstone often include mostly dark grey clay layers. this alternation of lithotypes facilitates the extraction of the. This alternation of lithotypes facilitates the extraction of the sandstone. *Macigno* is relatively more resistant to high temperatures, was also used for the construction of melting furnaces for the processing of ore from Elba Island.
The *Panchina*, given the ease with which it could be extracted and worked, represented the most used building material, both in the Etruscan and Roman phases of the city of Populonia.

The Fortress in Populonia – Conclusions

The robust qualities of the *Macigno* and the workability of the *Panchina* stone made it possible for the structure of the fortress to rise with a strict link to the landscape and the local materials. The fortress in itself is "iconic" it represents a defence system made for getting a complete sight all over the territory and for showing itself as a landscape marker that indicates the protection operating over the area. It is a perfect system for defending the surrounding area and protecting anyone inside in case of a siege, but nothing is done to hide the aspect and the evidence of the building. The bold structure of the walls is connected to the emerging rocks, the passage from the natural material to the stonework is well evident but fully exploited for using the cliffs themselves to be part of the fortification, strengthening the aspect of the front and reducing the overall amount of stonework with a solid and impenetrable mass.

Case Study 2: the fortress of Montecastrese, Camaiore, Tuscany, Italy

Montecastrese belongs to the category of villages fortified with a *Cassero* (*Castrum*, Castle). The importance of the *Castrum* of *Montecastrese* is attested by the toponym itself and by numerous

archaeological finds on the summit of the *Monte La Torre* (290 m above sea level) near the town of Camaiore. The castle was in a strategic position between the two torrents, with a good view of the Camaiore Valley, as well as of some roads and a passage that led to the silver and iron mines. Archaeological research allows for an understanding of the settlement evolution of Montecastrese. From the first settlement with perishable material, dating back to the VIII-Xth century, the castle gradually completed its development around the XIIth century (Gattiglia & Anichini, 2009). The castle consisted of a double wall: the first enclosed the Cassero, the highest part of the castle, which was probably inhabited by soldiers; the lower boundary, on the other hand, enclosed a village with about a hundred houses. These buildings were mainly located on the southwest side of the hill because the terrain was better there and sunnier. Two square towers were located at the northeastern and southwestern ends of the ridge.
The North Tower was probably the keep (mastio); it was surrounded by a defensive wall, closed on the east side by a guardhouse. The southern tower was connected to an earlier rectangular building, thought by archaeologists to be a Dongione (residential tower) that dominated the Camaiore valley (Gattiglia & Tarantino, 2013). The remains of the central tower are still there: the cut-off base and collapsed main body, still lying on the ground but split in two in recent times, perhaps after an earthquake, probably in occasion of the shake happened in 1955 (centered in Equi Terme, with a strength of 5.45 or in the one from 1982 (centered in Camaiore, with a strength of 4.28). Some large fragments were observed in this area, whereas others probably fell downstream. Historically, the tower collapsed due to the destruction of the castle after the conquest of the fortress by the army of Lucca in 1224. At that time, Montecastrese was involved in a long war between Lucca and Pisa to control the coast. Many castles were gradually taken and destroyed until Lucca completed its occupation of the coastal area in 1254. After the conquest of the castle of Montecastrese, the main tower was voluntarily demolished (as the traces of mine work show) and collapsed in the northeastern part of the complex. The inhabitants of Montecastrese were then forced to move to the new town of Camaiore founded by Lucca. The site was then gradually abandoned until olive trees were planted in this area at the end of the fifteenth century. This allowed archaeological remains to be partially preserved. During the XXth century, a series of excavations revealed the most important remains of this settlement.

Geology Aspects

In the Italian region of Tuscany, the town of Camaiore is situated in the province of Lucca. The Apuan Alps, a mountain range that stretches along Tuscany's coast and is renowned for the world-famous white marble quarries, includes the hills that surround Camaiore. The geology of the area is complex and has been shaped by a long history of tectonic activity, erosion, and weathering. The geology of the hills around Camaiore is characterized by the presence of several geological formations, including metamorphic rocks, sedimentary rocks, and igneous rocks. Metamorphic rocks in the area include marble, gneiss, and schist, which were formed through the metamorphosis of pre-existing rocks due to intense heat and pressure. Sedimentary rocks in the area include sandstone, limestone, and shale, which were formed by the accumulation of sediment in ancient seas and rivers. The hill of Monte Castrese is formed by Maiolica. It is a sedimentary rock dated to the Barremian (about 130 Ma) and formed by calcilutites, pelagic deposits with a grain size of less than 0.062 mm. These are well-stratified rocks with a light gray to whitish color in layers of average thickness from 15 to 20 cm which also reach thicknesses of up to one metre. Sometimes the layers have at the base clayey-marl intercalations ranging in color from wine red to greenish between one layer and another. The presence of marly layers greatly favored the extraction of the ashlars. The majolica has been affected by faults that have created fractured areas that allow the infiltration of water often allowing the formation of suspended aquifers in which the springs are arranged in contact with the underlying impermeable formations (explanatory notes sheet 260 - Viareggio - CARG Project). In this case the geological, hydrological and geomorphological factors have contributed to making Monte Castese an ideal place for the demographic development it has had. It is a landscape offering multiple options for the settlement of fortifications, offering various opportunities for retreating from the coast in case of attacks from the sea, but at the same time not easy to defend against incursions coming from the inland.

The Fortress of Montecastrese – Conclusions

The fortress of Montecastrese is a symbol of an era in which the balance between the various dominions was measured by the totality of their fortifications: The higher the walls, the larger the village, the higher the number of inhabitants and thus their ability to influence the balance. The higher the towers, the broader

the control. Construction was done with local materials to reduce the overall building effort but soon moved from wooden to stone architecture, just as the attack, siege and subsequent destruction were based on direct physical confrontation. The demolition of the Montecastrese fortress is a direct testimony of such a direct relationship, a kind of "inverted courtyard" aimed at destruction. The unexpected event of the tower falling on itself instead of falling to pieces seems like the materialisation of a tarot card turned into reality. It shows how surprising the behaviour of these structures can be in dramatic events. Last but not least, the choices made in defining the settlement, with a rock capable of supporting towers for visual domination, together with the steep flanks and the use of local materials, contributed to the "disappearance" of the fortress, which returned to the natural environment a few years after its destruction, while the surviving settlements were slowly put to agricultural use.

Case Study 3: the rupestrian settlements in Kapadokya Turkey

When people visit Kapadokya they are in the centre of Turkey, a geographical centre, distant from the seas, on a territory of volcanic origin that over time has been excavated and eroded by natural and human actions to become an incredible landscape to any visitor eye. The appearance of a natural environment with a "built" appearance has certainly stimulated the first inhabitants of these areas and the long line of their successors, intervening on the rock masses by digging shelters, deposits, houses, churches and entire cities (Jolivet-Lévy, 1991; 2002). The rock has thus crumbled and weakened and the whole of the excavations, while richly defining the territory, has accentuated the degradation and natural wear of the material, collapsing and transforming interiors into facades, showing beautiful details about to dissolve: a rich sample of fleeting wonders. The patrimony of Kapadokya appears today destined to a vast loss, incapable of supporting the admirable tourist load, which can only be partially preserved and for this reason even more exceptional in its last phase.

Geology Aspects

The geographical position of Kapadokya made this land an essential part of the geological system in the Eastern Mediterranean basin (Kuzucuoğlu, 2019). This area has a high density of particular landscapes that combine specific natural landforms, like badlands, canyons, and so-called "fairy chimneys", and human-designed landforms like caves, rupestrian churches and settlements (Sarıkaya et al., 2015). This region has specific geological structures and geomorphological landscapes dominated by volcanic and tectonic processes that began about 15 million years ago, in the middle Miocene, (Dewey and Şengoer, 1979). In this context, vigorous magmatic activity produced groups of geologic and geomorphologic features that created a variety of volcanic accumulations that intermingled with active tectonics that controlled a maze of small to wide basins scattered throughout the region (Dhont et al. 1998). Erosion by rivers and slopes (deep and shallow), responding to rock resistance and climatic influences, overlaid the volcanic substrate with different forms. During the late Miocene/early Pliocene (about 5 million years ago), floodplain formation occurred in interaction with shrinking lakes, while at the same time, volcanic products began to mix and intermingle with ongoing sedimentation. During the Pleistocene (from about 2,5 million to 11.700 years ago), lacustrine and continental depositional environments similar to those of the Neogene continued to fill, forming large sedimentary basins and river beds. While environmental evolution during the early Pleistocene is still poorly understood (Guerbuez et al., 2019), the geomorphology and geology of this period are well-reviewed (Doğan et al., 2019), putting in evidence the role of tectonics and climate in the formation of the present-day landscapes of a region that was framed by volcanic events that built and destroyed outcrops and landforms. The resulting scenario is characterized by a system of valleys and peaks made of materials that are at the same time easy to excavate, carving spaces, and solid enough to guarantee a usable and stable structure after the carving is completed. These factors made possible the creation of the rupestrian landscape, allowing a very original exploitation of the natural stones into articulated and nowadays surprising settlements. Thus, the main characteristic of these kinds of carving is the need for accurate planning of any choices, while in case of damage, large cracks or partial fall of a part, the repairing is extremely difficult.

The Rupestrian settlements in Kapadokya – Conclusions

The era of rupestrian communities and carved buildings is passed, but the monumental phase endures, with exceptional resonance and vision, the meeting point of beautiful nature with astounding decisions that undoubtedly looked reasonable and effective in their days. Because of this, the large rupestrian sites,

the vast areas rich in various types of ruins, do not necessarily indicate a single phase in which the entire area was alive and active; rather, the impression of the ruins can suggest a system that, despite developing over a long period, was fully utilised at the same time (Crescenzi, et al., 2016). Even while there are a staggering number of rupestrian churches and communities, neither the coexistence of the population nor the simultaneous use of complete settlements can be demonstrated. Nonetheless, the place gives off the impression of being a large community; the history that can be learned on a tourist visit to one location may leave them more intrigued than necessarily inspired. The most popularly held opinion can frequently contain both true parts and potentially deceptive aspects, thus those involved in reconstruction must read and listen while still maintaining their logical and interpretive skills.

Case Study 4: the citadel on the Pionta Hillock, Arezzo, Tuscany, Italy

The Cathedral of S. Donato was the nucleus of an ancient and independent citadel outside the city walls of Arezzo (Tafi, 1995). It was built from the VIIIth century onwards in place of Etruscan and Roman remains. In the XVIth century it was completely demolished because of its political imbalance with the Medici political strategies: in 1561 Cosimo de Medici ordered the destruction of the walled citadel and had all the buildings razed to the ground. But the memory of the place remained, supported by some elements saved and reused in other churches, some frescoes and paintings depicting the citadel, and by the "myth" that developed around the first cathedral of Arezzo, the church of S. Stefano e S. Maria, and the second, the church of S. Donato (Tristano and Molinari, 2005), a rich and almost experimental building (Pizzi, 1995). The Cathedral of S. Donato was characterised by a complex layout, with a central and symmetrical plan organised around a large empty space. After the destruction, the materials of the buildings were probably reused elsewhere, while only small parts of the earlier churches and chapels were adapted in new constructions (such as the small church of S. Stefano, built in 1610, which contained a small crypt from the original settlement). Various interventions over the centuries have rearranged the hill's terrain, and it was not until 1960 that a real archaeological excavation campaign began. This brought to light the ruins of the Romanesque church of S. Maria and S. Stefano with various smaller remains (Melucco Vaccaro, 1991). However, the few parts of the citadel that are still visible do not offer a revealing plot.

Geology Aspects

The Pionta Hill represents a rock relief surrounded by an expanse of sediments created by the lake that dominated this area in the Pleistocene. These conditions created the ideal topographical conditions for the construction of the citadel. The rocks on which it stands are Feldspathic Sandstones with a coarse grain size of grey-blue when freshly cut and ocher yellow when altered. As could be observed during the survey campaign, the topography was remodelled several times to create the foundations and to redistribute the debris from the numerous demolitions.
During the study of the geomorphology of the area, a paleosol was identified, the sandstone was altered and turned to brown-red colour by the presence of newly formed oxides and hydroxides. The soil identified corresponds to the original walking surface, most likely formed during the permanence of the lake in the area.
By placing the precise location of the paleosol outcrops on the digital survey, it was possible to obtain the original morphology of the Pionta Hill, at the time of the first settlements. The reconstruction shown as a horizontal section shows an almost horizontal level, a probable levelling surface on arenaceous ground that offered ideal conditions both for the burial of the dead and for the structuring of the nucleus of a citadel. The identified surface and the ground found in the so-called “area 1000” under the apse's land level represent the floor surface existing before the arrival of man. This information put into reaction with the digital survey is a key horizon that facilitates the archaeological analysis of the site.

The Citadel on the Pionta Hillock – Conclusions

The inspection of the area and the analysis of the articulated digital surveys conducted in the area in time show clearly how the hill has been the subject of numerous transformations, where the ruins were moved, and mixed, changing in a significant way the aspect of the place, giving it the most convenient one according to some occasional intentions. The hard demolition operated in the XVIth century completely obliterated the original trace of the citadel, causing the total disappearance of every building if not the basement of the old church of St. Stefano and some walls and elements that probably were yet under the level of the soil at that time. The intervention was so thought that even the basement of the defensive walls

completely disappeared leaving no trace. In such a condition, it seems more important to reply to the question "Why something remained" than "Where were the buildings at that time?". In the end, the Pionta hillock was transformed from its natural form into a fortified citadel and then back to be a hillock reshaped by the mixed fragments of the accurate demolition. A powerful cancellation that operated with a strong efficiency rarely seen in any other context.

Case Study 5: the "Fortezza Vecchia" in Livorno, Tuscany, Italy

The Old Fortress's original core, which dates to the X-XI century, is represented by a square brick tower on the outskirts of the Pisan harbour. This tower was likely once a part of the *Castrum Liburni*, which was said to have existed in 1017 (Piancastelli, 1995). It was the earliest habitation on the rock formation that would later eventually become the complex's basis and presumably also the location of the material quarry. A key location for the intricate network of sighting systems connecting the coast, hinterland, and islands to protect and garrison the region, with a direct view of the sea (Guarducci, Piccardi, Rombai, 2014). The *Castrum* saw a series of changes in ownership from 1076 to 1120, the year in which it became the possession of the Archbishop of Pisa Attone (Cagianelli & Matteoni, 2003). In this phase, the events of Livorno are closely linked to those of the Republic of Pisa, and after the victory of the latter against rival Genoa in 1241 off the island of Giglio, is presumably built the tower circular plan, then called "Keep of Matilde" (Piombanti, 1903). Two towers were connected by a single wall in 1376. The organisation that was founded was given the name *Rocca Nuova*, and the "Quadratura dei Pisani" designation is retained on the building today. The new fortification is quadrangular and is situated in a protective bay (Ceccarini, 2009). With Pisa's decline, the castle was acquired by the King of France in 1404, who asked Genoa's governor, J. le Meingre, to fortify it. In the historical phase of ballistic innovations, and with the introduction of the first artillery weapons, it became necessary to place loopholes and gun mouths in relation to geometrically studied shot ratios. After the French interventions, the fortress passed into the hands of Florence (1405). This brought to the reorganization of the fortress by Antonio da Sangallo: This further transformation of the fortress dates back to the XVIth century, when the Medici, once again masters of Florence and Livorno, wanted to create a new organization to defend the port of the city (Vivoli, 1903). The complex's construction, which bishop Giulio de' Medici wanted and funded, started in 1519 with the building of the "dell'Ampolletta" bastion and the eastern and southern curtains. This work continued in 1523 with the building of the *Canaviglia* and *Capitana* bastions, and it was completed in 1533. The excavation of the moat that would divide the fortress from the town began in 1520. The entrance system was established at the start of the XVIth century by incomplete perimeter walls. Two gates were erected, one at a larger pier (the present-day *Molo del soccorso*), overlooking the port, and the other at the city gate, which led, via a ramp, to the main platform known as *Piazza del Castello*. The Grand Duke Cosimo I *De' Medici* then desired to carry out a significant intervention in the entire fortress, converting it into a defensive garrison by finishing many of the structures, fortifying the preexisting systems, and constructing a building integrated into the structures. This structure, which was finished in 1546 and included a portion of the "Quadratura dei Pisani", has not survived to the present day and was destroyed during the Second World War (Ceccarini, 2009). In 1572, the courtyard for the new port began but was put on hold when the Grand Duke passed away. The proposal by Bernardo Buontalenti was launched with the installation of the new Grand Duke Francesco I, in which the Fortress remains isolated and serves as the fifth basis of the new city walls. When the Grand Duchy of Tuscany moved to Lorraine in 1769, Old Fortress became the location of military barracks (Nudi, 1959). Later, during the Napoleonic occupation, several fortification-updating activities were begun, including the building of ramparts and the opening of numerous gunboats. During the XVIIIth and XIXth centuries, the stronghold progressively started to serve as more barracks and "containers" for weapons.

The stronghold underwent additional architectural and functional modifications around the start of the XIXth century. This included the conversion to a prison in 1825. The fortification was included in the neighbouring municipal district after Italy's unification in 1865 and later became a part of the port's customs district. From this point forward, a distinct division between the upper part mostly utilised as a weapon and ammunition depot, and the lower part, primarily used as a storage facility for wines, oils, and goods intended for export, is to be established. The opening of new doors to ease the processing of commodities was one adaptation brought about by this considerable alteration. Although the stronghold was transformed by the use of gunpowder, it was twice endangered by the development and improvement of explosive weapons in the 20th century. The ship Etruria exploded on August 13th, 1918, causing significant damage, especially to the Francesco I Medici structure of the *Canaviglia* bastion, the outside walls, and to the balconies of the *Quadratura dei Pisani*. After being repaired, the castle continued

to be used as a military barracks until the Second World War but was then bombed by the Allies: the complex was attacked by some bombs that struck the explosive deposits in the northern area on May 28, 1943. This caused damage to the bastion of the *Capitana* and the network of spaces and tunnels in that sector. The stronghold was given to the Ministry of Education during the post-war period as part of the state's restoration and reorganisation (1948). In the years that followed, Superintendence, through P. Sanpaolesi and S. Asuant, initiated several interventions intended to recover, restore, and adapt an extremely damaged building. The entire operation resulted in the walls being reinforced, but it also resulted in the demolition of many hazardous components that are thought to be difficult to salvage. Fortresses began allowing visitors in 1969. The restoration projects persisted throughout the 1970s, 1980s, and 1990s; the war-related wall curtain damage was gradually repaired, and the serious damage to the *Capitana* bastion was consolidated.

Geology Aspects

The city of Livorno is situated on the Tyrrenian Sea, on the western coast of Tuscany, Italy. This area is characterized by a mixture of sedimentary and metamorphic rocks. A substantial succession of sedimentary rocks, including sandstones, shales, and marls, underlies Livorno's coastal region. The Cretaceous period (145–66 million years ago), when the region was covered by a shallow sea, is when these rocks were deposited. The Apennine Mountains, which extend around the Italian peninsula, were created by the subsequent uplift and folding of the sediments during the Apennine orogeny (approximately 50 million years ago). Along the coast, the sedimentary rocks are overlain by a series of coastal dunes and sandy beaches, which have formed due to the action of waves and currents. These beaches are composed of sand and gravel that have been transported and deposited by the sea.

The Livorno region is renowned for its metamorphic rocks, like gneiss, schist, and marble, in addition to its sedimentary rocks. The formation of these rocks, which are often found in the hills and mountains that surround the city, is thought to have occurred at the same time as the Alpine Orogeny that influenced the sedimentary rocks. With a mixture of sedimentary and metamorphic rocks that have been sculpted by historical and contemporary geological processes, the geology of the coast in Livorno is complex and diverse. The area chosen for the settlement of the Fortress was partially a cliff which was used since the first construction as a base and as a quarry, thus, when it came the time to expand and conform the structure to the new rules of military buildings, all the architectural work was mainy based on the use of bricks, with the presence of larger blocks only in some parts and for some vaults. The Fortress was based on a system of stable cliffs along the coast but was soon extended by modifying the original soil and expanding it using local stones and artificial materials. The intense use of bricks gave this fortification its specific aspect, in it all is shaped to the rules of cannons both in attack and in defence. The choice for the use of artificial stone and smaller pieces is a sort of antefact to the creation of contemporary fortifications, with an high quality masonry work often integrated by larger stones aimed to enhance the real and the apparent strength of the walls.

“Fortezza Vecchia” – Conclusions

The fortress is a step towards the abandonment of the direct link between nature and fortifications, the technology of that time was yet enough to allow a robust transformation of the original ground, allowing channels, and allowing the building of large structures made of small elements, so to facilitate the transportation of building materials. All the efforts made for the creation of the “Old Fortress” during the Florentine dominion, seems aimed at creating an efficient stronghold to show, maybe even more than operating, the safety of the Tuscan Grand Duchy in the main Tuscan harbour. The choice of inserting Francesco De’ Medici’s Palace on one of the bastions seems to confirm this will of demonstrating the intentions of the old governance. At the same time, this fortress may efficiently represent the change in the way of conducting a conflict after the introduction of aerial weapons. The use of large structures along the sea seems immediately the opposite of any correct defensive choices, too large, unprotected from aerial attacks.

Case Study 6: the battery of Valdilochi, Liguria, Italy

The “Valdilocchi Battery” belongs to the last age of the large fortress, capable to resist ground attack while showing the aspect of an inexpugnable stronghold. Sited on the top of a hill in the eastern part of the La Spezia Gulf, this battery had the function of second-line defence to control the neighbouring valleys (Di

Grazia & Marinaro, 2015). The particular pentagonal plant and the state of excellent preservation, except for a part of the collapse on the front of the gorge due to the German bombing, make it an artefact of great value. The role of the Valdilocchi battery can be better understood only if it is related to the entire defensive system of the military maritime arsenal (Marmori, 1976). The Valdilocchi Battery is, in fact, a small piece of the complex fortification system of the Gulf of La Spezia. Unique military architectural heritage by extension in the world was built mainly in the period from the rise of Napoleon Bonaparte until the Second World War (Danese, 2011), which integrates fortifications and castles of previous eras with modern architecture for the close defence of the most powerful Italian naval base and the industrial centre built next to it. The defensive system consisted of two fronts of fortifications: a seafront against attacks from the gulf by naval units and a land front against attacks led by land troops. The land front was divided into a network of independent fortifications as a first line, a continuous safety belt for close protection as a second line, and a perimeter wall armed around the city as an extreme defence (Marinaro et al., 2018). Between the First and Second World Wars, there was a second phase of fortification, which increased the number of military works and modified the layout of some of the existing ones to prepare them for anti-aircraft defence. The latter is the battery of Valdilocchi, which is inserted in the eastern front of the gulf and belongs to the land front that extends from Mount Valerian to Mount Rocchetta. It was one of the first works realized (1880) intending to prevent the entrance to the gulf from passing towards the plain of the Magra river (Marinaro & Di Grazia, 2017). The pentagonal-shaped battery had a main front articulated on two semi-batteries oriented to the North and Northeast, each with two double brick pitches separated by crossbeams. A fifth double pitch is placed on the left side of the entrance. The entrance opened into the gorge belt to the left of the median point, with a drawbridge counterweight on a continuous dry ditch-type "diamond" that revolved around the entire structure, protected by three half caponiers and an ordinary caponier on the central salient that beat all the branches of the ditch. Inside the fort, to the left of the entrance, were the Guard Corps and the officers' quarters, while on the right were the troop quarters, from which the shoe tunnels led to the caponier and formed a cavity of insulation while acting as a lighting tunnel for the powder stores. The courtyard was the heart of the battery; there were various warehouses, kitchens, toilets, and a room with a circular plan, under which a cistern of rainwater was obtained, which led to the western caponier and the ventilation and lighting gap under the left half-battery. On the courtyard, there are also access corridors to the eastern caponiere and to the dust deposits placed at the right end of the gorge compared to the entrance, in a secluded and protected position compared to the enemy shooting, kept dry, and ventilated by cavities on two sides. The charge and projectile packaging laboratories and the loaded shell warehouse were located under the right half battery. To be traced back to the most probable toponym "Valdilochi," the etymology suggests a link with the Latin locus, in the extended sense of a place, inhabited by a family, but also a farm, or property. In essence "Valdilocchi" was a valley inhabited, guarded and cultivated. This is perhaps due to the usual irony attributed to the fact that today, not only this battery but the whole hill has been completely forgotten, gradually coming out of the circuit of the inhabited and lived places of the east coast. A pioneer forest of pines and robins took the place of the fields, and the characteristics of the once distinctive rural landscape were replaced by rough and uncertain features of the urban landscape of the industrial and productive suburbs. The construction of the Military Maritime Arsenal and of the entire defence system in its equipment also determined the urban and demographic growth of the city of Spezia in the twentieth century experienced a period of great expansion leading to direct connection with many small villages (townships) dotted the gulf, which became neighbourhoods.

Geology Aspects

Liguria is a region located in the northwest of Italy, bordered by France to the West, Piedmont to the North, and Tuscany to the East. The area is part of the Apennine mountain chain, which was formed by the collision of the African and Eurasian plates. The collision began in the Late Cretaceous period, around 70 million years ago, and continues to the present day, resulting in ongoing tectonic activity in the region. The region has a diverse geology, with the coast and Gulf of La Spezia displaying unique features. The Ligurian coast is characterized by a series of parallel ridges and valleys that run perpendicular to the coast. These ridges are the result of the tectonic activity that has affected the region throughout geological history. The rocks that make up these ridges are predominantly sedimentary, with layers of sandstone, shale, and limestone formed during the Triassic and Jurassic periods. These rocks were then uplifted and folded during the Alpine orogeny, which took place during the Tertiary period, resulting in the formation of the Ligurian Apennines. The Gulf of La Spezia, also known as the Gulf of Poets, is a deep inlet that extends for approximately 12 kilometres inland. The geology of the gulf is characterized by the presence of a large

anticline, a fold in the rock layers that dips downward on both sides. The anticline is composed of alternating layers of limestone and marl, which were deposited during the Cretaceous period when the area was covered by a shallow sea. The folds in the rock layers were then caused by tectonic activity during the Alpine orogeny. The rocks in the area are predominantly sedimentary, with some volcanic and metamorphic rocks. The sedimentary rocks include limestones, sandstones, and shales, which were deposited in marine environments during the Mesozoic Era, between 252 and 66 million years ago. These rocks have been folded and faulted by the ongoing tectonic activity, resulting in a complex series of structures that are visible in the landscape. The volcanic rocks in the area are mainly of the Tertiary age, between 66 and 2.6 million years ago, and include basalts and tuff breccias. These rocks were formed by volcanic activity associated with the opening of the Tyrrhenian Sea. Metamorphic rocks in the area include schists, gneisses, and marbles, which were formed from pre-existing rocks that were subjected to intense heat and pressure during the Alpine orogeny, which began around 30 million years ago. The overall morphology of the area of the battery offers then solid ground, a well-shaped system of hills protecting the battery from the sea and the presence of stone materials with easy workability and excellent qualities in front of the fortification needs.

The battery of Valdilochi – Conclusions

This may be considered in the group of the last fortresses before the advent of aerial war weaponry, built before the growth of military aeroplanes, it shows a series of tentative for making it capable of "disappearing" or at least being less noticeable by an aerial attack. These strategies seemed to work quite fine its destruction was caused deliberately using mines and not by aerial bombing. Even in this case, probably with an unpredictable phenomenon like it was centuries before in Montecastrese, the fortress was partially demolished, but a large part just moved like a single block for various centimetres all in one direction. The mixed use of local stones and reinforced concrete, together with the robust construction probably defined the creation of a massive and sturdy structure that helped the event. Nevertheless, the drastic event caused the end of the use of this settlement. once abandoned the fortress completely disappeared into the woods until its very recent recovery. A curious fact is that the works that were done to improve the mimetic level of the fortress, provided a thick level of terrain all over the coverages, this integration, after the abandonment, it created good conditions for plants and trees to conquer back the building. After a long period of abandonment, from 1945 to 2019, the fortress was finally cleaned from the abundant vegetation, consolidated and brought back to public access.

Case Study 7: bunkers in "Punta Bianca", Liguria, Italy

The concrete bunkers along the Tyrrhenian coast in the Gulf of La Spezia are remnants of Italy's World War II-era coastal defence system. These bunkers were built by the Italian military as part of the "Vallo Alpino" (Alpine Wall) defence line, which was constructed in the 1930s and 1940s to protect Italy's northern borders from invasions. The Gulf of La Spezia was considered an important strategic location because it provided access to the naval base, which was a crucial component of the Italian naval defence system. The concrete bunkers were built along the coast to protect the naval base and surrounding areas from potential enemy attacks. Between 1915 and 1923 the bunkers of the "Dante De Lutti" battery in Punta Bianca were built by the Italian navy. They were entitled to Dante De Lutti (1886-1911) who was a second lieutenant on the crew of the royal battleship "Napoli". He was wounded and disappeared in combat against enemy forces in the Wadi of Derna during the Italo-Turkish War. The battery was armed with two 152/45 guns and a 120/40 piece of light. The Battery *De Lutti* belonged initially to the system of fortifications entrusted to the MILMART, the Marine Artillery Militia, and then, after the armistice of 8th September 1943, under the control of the German army, as well as the various batteries located in the territory of La Spezia, which after being taken by the German army were strengthened in anticipation of a possible attack from the sea, which however did not happen, and were used as the extreme bulwark of the Gothic Line. Several times the "Dante de Lutti" suffered bombing. It was from Punta Bianca that Massa was bombed after the entry of the allied army and, in retaliation for this action, Montemarcello and Punta Bianca suffered a fierce air attack, supported by the shots fired by a British destroyer, on the 13th December 1944 the village of Montemarcello was hit causing the death of 35 people and forcing the survivors to leave the settlement. The last days of World War II, just before April 25, 1945, had Punta Bianca as the scene of the last clash over what remained of the Gothic Line: A first American attempt on 17th April was repulsed by the *De Lutti* battery, which was finally disarmed by the Buffalo 92 division on 20th April, shortly after the Allied army broke through the Gothic line at Bologna. After World War II, these bunkers were abandoned and left to deteriorate. The coastal bunkers in the Liguria region, Italy, were designed and built to blend in

with the natural landscape and topography of the region. The architecture of these bunkers was heavily influenced by the principles of military engineering and the need to create fortified structures that could withstand enemy attacks. The bunkers were typically constructed using reinforced concrete and designed to have thick walls and domed or sloped roofs to protect from bombs and shelling. The entrances and openings of the bunkers were also carefully designed to minimize their visibility and provide maximum protection for the soldiers and equipment inside. Many of the coastal bunkers in Liguria were built in strategic locations, such as hilltops, cliffs, and coastal promontories, to provide clear lines of sight and fields of fire for the soldiers manning them. Some of the bunkers were also built underground, with only the entrance visible above ground, to further conceal their presence and make them more difficult to detect and attack.

Geology Aspects

Even if the geology of Punta Bianca is characterized by very complex and articulated features (Iaccarino et al., 2015), the relationship between the nature of the place and the settlement is more connected to the morphology and strategic positioning of the cannons than by any possible relationship with the materials of the place. The bunkers were built in full concrete manufacturing, with essential shapes and aimed to integrate nature with a minimal mimetic effort. It is then the reinforced concrete to drive and organizes any choice in the construction of these fortifications. Concrete is a versatile and durable building material that has been widely used in Liguria for many decades. The region's rugged terrain and mountainous landscape made it difficult to build with traditional materials such as wood and stone, making concrete a popular choice for construction. The region's many tunnels and viaducts were also constructed using concrete, as were the bunkers and fortifications built along the coast during World War II. One of the advantages of concrete as a building material is its ability to adapt to different environments and climatic conditions. In Liguria, where the climate can be harsh and humid, concrete was often mixed with special additives and sealants to enhance its durability and protect it from the corrosive effects of saltwater and moisture. Despite its strength and versatility, concrete is not a completely indestructible material and can still suffer from cracking, spalling, and other forms of deterioration over time. To prevent this, regular maintenance and repair should be required, especially in coastal areas where the material is exposed to saltwater and harsh weather conditions, so the long period of abandonment of the bunkers did not facilitate their preservation, causing the gradual deterioration of many parts.
When making reinforced concrete for bunker construction, the characteristics of the sand used are important for ensuring the structural integrity of the bunker. Some key characteristics to consider include: Particle size, the sand should have a consistent particle size distribution, with particles ranging from 0.1 millimetres o to five millimetres in size. This helps ensure good compaction and reduces the risk of voids in the concrete. The shape of the sand particles should be angular, rather than rounded, to promote better interlocking and bonding with the cement paste. The sand should be free of impurities such as clay, silt, and organic matter, which can weaken the concrete and reduce its durability over time. Last but not least, the sand should have sufficient strength to resist crushing under the weight of the concrete. A commonly used measure of sand strength is its compressive strength, which should be at least 75% of the compressive strength of the concrete. The gradation, or distribution of particle sizes, should be such that the sand fills in the spaces between larger aggregate materials, promoting good compaction and reducing the risk of voids. In addition to these characteristics, it is also important to consider the source of the sand. Ideally, the sand should be locally sourced to minimise transportation costs and ensure consistency in quality.

“Punta Bianca” – Conclusions

The system of bunkers, with their large system of hidden and underground connections, may be considered the last step in “traditional” warfare, defined at a time when it was still time to consider the idea of firing a cannon from a fixed point; the relationship between distance, subject and firing range of the weaponry was still a valuable point, thus, the material of the construction where yet changed. The logic of excavating the material in place and the use of stone blocks or bricks were surpassed by the power of the projectiles, the use of reinforced concrete was mandatory, to reply to the need for more resistance to the increased strength of the bombs and to speed up the construction of the military space. The bunkers were steps towards contemporary warfare, with a construction logic all devoted to practical choices and efficiency, with no room for decoration or graphic choices. The bunker in a certain way

became the icon of war and its capacity of altering the landscape is something new in front of all the previous military architecture choices. The planning of these structures simply alters a small part of the landscape, it searches for inner spaces, cavities and tunnels, or just searches for proper soils where carving and excavating are easy. The mimetic aspect becomes the mandatory guideline to hide completely what's behind the small openings towards the open spaces.

Conclusions

All the fortifications have their time. They are the result of societies that want to consolidate, protect or expand their borders. Even if dedicated to specific purposes, they have shaped and characterized the landscape and the development of areas across centuries, their imposition of an "edge" between in and out of territory was tangible (and often is still tangible) even without the presence of large walls. A system of towers or fortresses along the coast or the hills and mountains was easily recognizable for what it was. They were planned for responding to a specific way of defending and attacking. The way of military planning was, and still is, the mandatory choice for any planning of military architecture. The changes applied in time accordingly to the terrible habits of weaponry and technological evolution kept on going until it made sense to use that specific building for military uses. For a long time, from the age of the great fortifications to the use of cannons to the invention of aerial war, the military-built heritage has seen a long transformation made of sudden architectural changes, until the moment when the possibility of bombing and attacking from the sky signed the sunset of the large overground buildings in favour of mimetic and underground structures. The option for destruction and the foolish enhancement of the accuracy and efficiency of the weaponry, caused the total renouncement of the "monumentality" of the exterior presence, making it preferable to hide underground any element. If something is left to the "spatiality" it is just dedicated to some well-hidden interior with such characteristics that it may transmit a sense of fascination and even disquietude. The relationship with the nature of the places seems to link directly to four factors: One, the possibility of exploitation of the territory to get the highest efficiency of the building in terms of controlling, defending or attacking. Two, the workability of the materials and availability of construction materials. Three, the possibility of connecting, and integrating previous structures, to extend a military network of built elements most efficiently. Four, no sentiments for too old or obsolete structures, what is no longer efficient or usable is transformed or abandoned accordingly to the new military needs, while any other compromise would be a weakness. What remains is a large heritage made of elements connected to events, stories and historical moments, marked by architectures that may appear unchanged by time or totally in ruins, but in all their range of cases, they keep a strong evocative strength, connecting to the feeble or robust knowledge of the visitor and bringing him to imagine the past. Making this interpretation coherent with the proper time of the building and making readable the main steps in the evolution of those constructions, with the opportunity of showing their link to the nature of the places, are a part of the various challenge of the recovery to the present of the past military architectures.

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Fig. 1. Front of the fortress in Populonia.

Fig. 2. The lines from the stone levels in the basement of the fortress and the stone cut to shape the floor of Populonia downtown.

Fig .3. Aerial views of the hill looking towards the sea and ruins of Montecastrese.

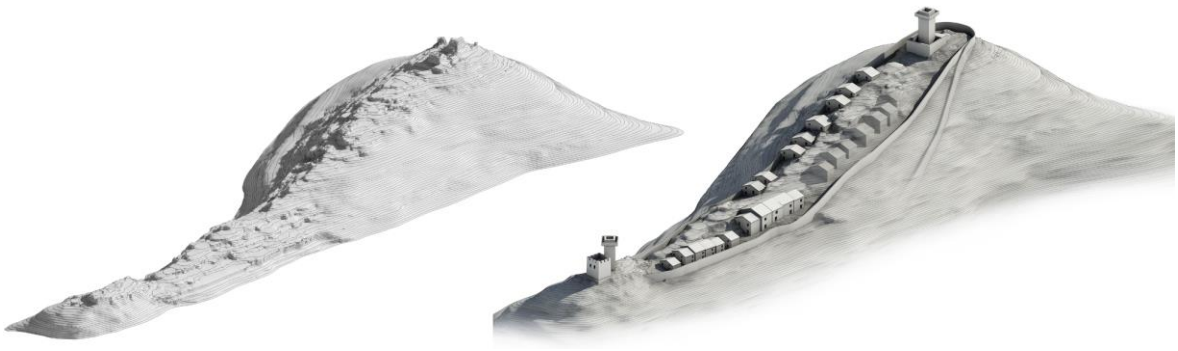

Fig. 4. Virtual reconstruction of the fortress of Montecastrese.

Fig. 5. The rupestrian landscape from Goreme toward Uchisar, Kapadokya.

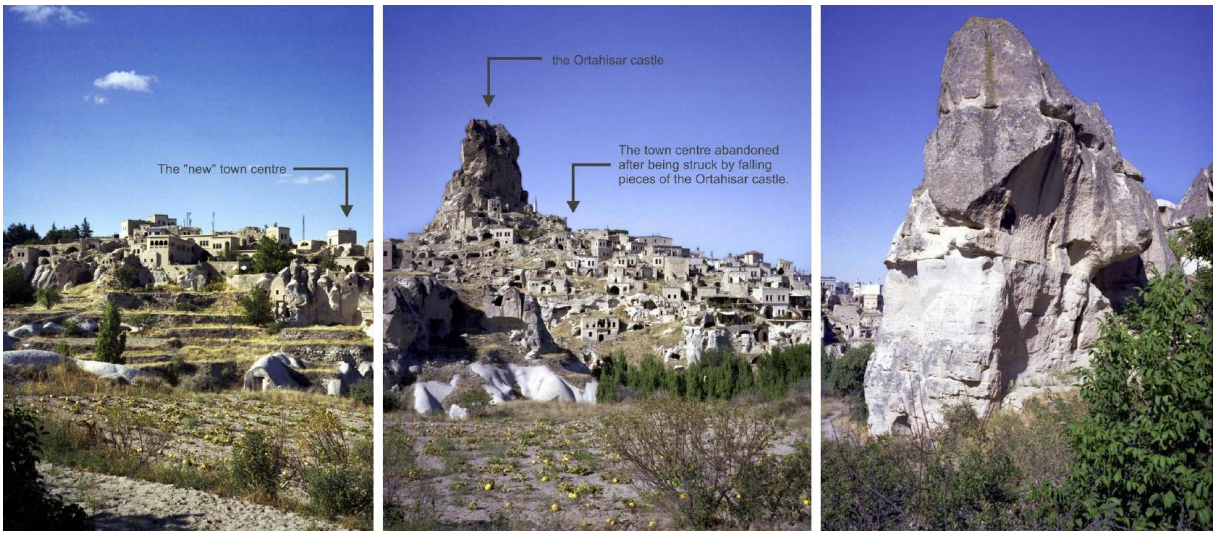

Fig. 6. The transformation of the cityscape of Ortahisar keeps probably a constant in the rupestrian settlement's evolution.

Fig. 7. Maybe represented by Giotto in one of his frescos, the citadel on the Pionta Hill, out of the walls of Arezzo, arrived in our time with only a few remains.

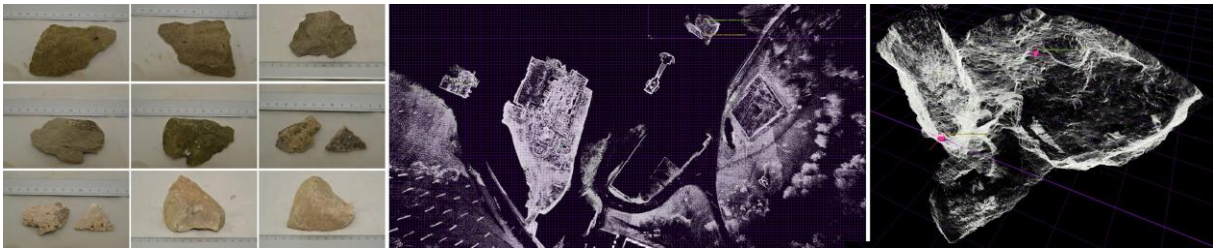

Fig. 8. Stone samples and the interpretation of the Paleosol in the Pionta citadel.

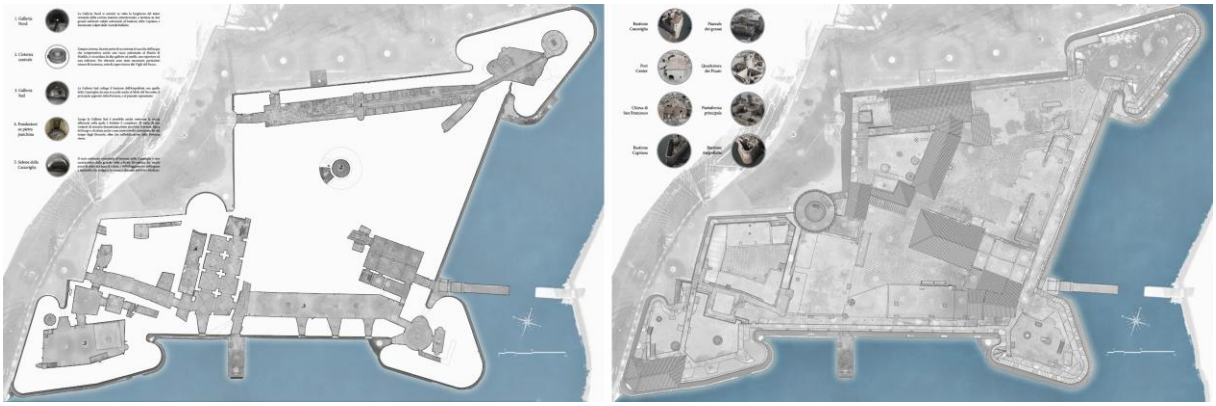

Fig. 9. Plan view of the ground floor and of the top of Fortezza Vecchia in Livorno, Italy.

Fig.10. Aerial views of Fortezza Vecchia in Livorno, Italy.

Fig.11. The Valdilochi battery coming out from the woods, sattellite images 2018-2023.

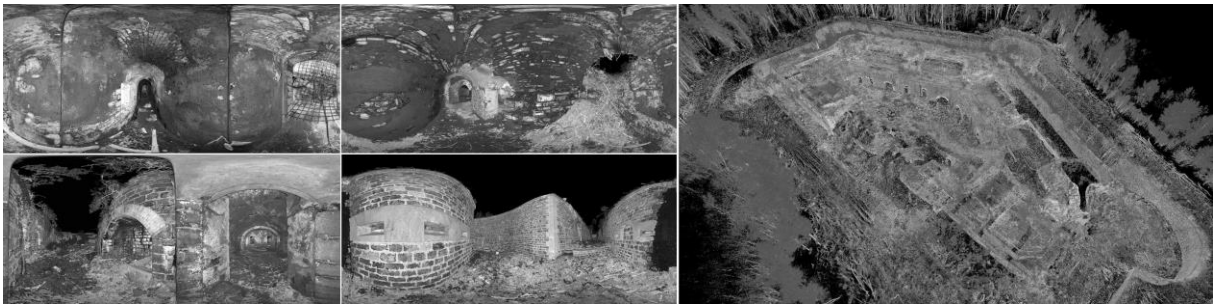

Fig. 12. The Valdilochi battery, digital survey 2019.

Fig. 13. Views towards the sea from the coverage of the main bunker.

Fig.14. External and internal views of the bunkers in their present conditions.

Fig.15. Infrared Panoramic view on the gulf and view in one of the tunnels.

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