From the medieval hypogeum of Positano's Main Church to the 1st cent. BC Roman villa: archaeological excavations, restoration and musealization of the site

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The architectural-monumental complex and the related study and representation interventions have an essential importance for at least three points of view:

1. Possibility to provide an appropriate space to mount Positano's museum, that can be organized between the two spaces of the underground crypts;

2. Promoting the local history that is strictly related to the structures through the restoration;

3. encouraging both tourism and culture through a seasonal adjustment of the tourist experience, making it no more only linked to the sea bathing.

These were the main aims that have been achieved through the museum organization in the illustrious spaces of the Main Church: a religious building dating back originally to the 9th cent. and that is currently the result of several documented modifications starting from the 16th cent. Positano's landscape appeal boasts ancient roots and it currently reaffirms its quality in the archaeological value of the perfectly preserved 1st century BC, Roman villa located below the main religious monumental complex in Positano. During the last ten years the joint commitment of Positano's Municipal administration[1] and Salerno's and Avellino's Authorities of Fine Arts and Landscape allowed two successive works campaigns (2003/2006; 2014/2016) to dig up a priceless part of the above mentioned Roman villa.[2] The importance of the archaeological finds, the suggestive position descending at a depth of 11 metres below the planking level of the medieval hypogeum (fig. 1) of the Main Church are the proof of the embedded historic artistic roots of the coast town. Architecture, wall painting and the household furnishings prove a priceless value of the cultural context. After the accurate excavations works (fig. 2), the attentive reinforcing of the structures, the careful restoration of the frescoes and the furnishings (bronze, ceramics, etc.), and the creation of elevated weathering steel and extra clear-tempered glass paths (walkways

Fig. 22
Image of the monumental complex of Santa Maria Assunta before the facade construction in 1927 (Daniele Esposito Collection)

[1] It's worth mentioning Positano's Aministrazione Comunale that was proudly committed to recover its history, to support the plan of a museum and a site where the everlasting past memories can be told and relived. Special thanks to the engineer Raffaele Fata, Procedure Manager of the municipal technical office for choosing me as works designer and director. Moreover, I want to thank to Positano's mayor Michele De Lucia. Among the essential professionals I can cite the archaeologist Matilde Romito, who first made a scientific survey of Positano from its origins to nowadays.

[2] The scientific direction of the archaeological survey was by the Superintendent Adele Campanelli and the coordinator director of Salerno's and Avellino's Archaeology Superintendence, Maria Antonietta Iannelli in collaboration with the archaeologist Francesco Praianò during the excavations between 2003 and 2006 and with the archaelogists Luciana Iacobelli and Riccardo Iaccarino between 2014 and 2016. The restoration of the archaeological findings was managed by the restorer of Salerno's and Avellino's Archaeological Superintendence Valter Tuccino between 2004 and 2017.

Figs. 1-2
View of the main room Crypt where a portion of the 1st cent. BC Roman villa came out.

Fig. 3
Emergency interventions made by the restorers during the archaeological excavation

Fig. 4
View of the archaeological excavation during the materials discovery

and stairs), people can visit the part of the medieval hypogeum under which Positano's most beautiful and ancient "house corner" came out. Its frescoes, whose colours are perfectly preserved, represent suggestive and illusionistic landscape perspectives, architecture, humans and animals, decorations. The restoration of the museum paths makes the stratigraphy of the modifications, which Positano's history produced (figs. 3-4), recognisable. The evolution of the archaeological site has always been conditional on the synchronicity of the aspects that influenced the realization of each work. First of all, the logistic aspect of the transport that lied heavy on the whole work. The completion of the works is the result of a combination of actions and of the collaboration among several professionals on the site. Therefore, what has been realized is the outcome of multidisciplinary discussions and continuous debates to solve the problems and chose the appropriate restoration techniques. So, it can be defined as a "dialectical construction site", that involved Authorities and Institutions of Research and Diagnostics and Preservation as the Istituto Superiore Centrale per il Restauro di Roma (ISCR).[3] Since the first excavations campaign in 2003/2006 the ISCR concentrated on the assessment of the environmental conditions of the hypogeum, on the probable evolutions (concerning the archaeological site and the museum) and on the preservation of the structures through the chemical characterization of the construction materials as well as on the decay process. Through the strenuous scientific activities and the restoration of the spaces and finds Positano strengthens its monumental identity that can be handed down both from one local generation to another and from the inhabitants to the tourists visiting it; all of this has been made possible thanks to a conscious policy and a renewed interest in the past considered as heritage

[3] As regards the research by ISCR made by the biologist Marco Bartolini, the archaelogist Barbara Davidde, the fisician Elisabetta Giani, the restorer Antonio Guglielmi and the chemist Fabio Talarico see the scientific paper in the chapter about the diagnostics.

of both local and global knowledge. The interventions preserved the physiological materials decay representing an indelible sign of the time able to certify its historic value. The chosen restoration aimed at not only limiting the conservative-technical problems in the hypogeum but also at "preserving and giving the formal and historic aspects of the monument prominence", according to Venice Chart art. 9.

Between cognitive investigation an architectonic survey and analytic study of the cultural heritage

The site restoration plan has been always influenced by the difficult fact-finding enquiry of the resource, that has been continuously enriched with studies and investigations to better read and understand what came out from the architectonic stratigraphy and the materials abundance. The restoration and preservative choices have been constantly based on both the movables and immovables knowledge, following a parallel planning suitable for the definition of the techniques, the means and the aims in order to know all the findings of The Archaeological Museum in Positano. The dimensional, material, preservative survey of the architectonic stratifications, where the last 2000 years of Positano's history can be traced, seems to be the best way to read and know the resource, beside the indirect archives research. It represents a relevant activity to collect a local history database that will be kept in spite of the natural material decay. The planning phase was very important, when every choice of preservation, restoration and musealization was made. Thanks to the database it will be possible to manage the cultural heritage, it will represent the record of the restoration (a comparison between before and after), a support for the future interventions or the monitoring and the upkeep planning. The architectonic survey through the wall portions superimposition and sharing, besides getting all the metrical data of the structures, is the most suitable instrument of fact-finding survey and it is the starting point for every type of action on the site and its content[4] (figs. 1-3). The formulation of the architectonic survey between plans and sections, analyses and highlights the relation between the wall structures, the vulnerability of the archaeological excavation, the decay typology and distribution. Therefore the archaeological survey has been widened to the monumental complex of the above Main Church and to the boarding urban spaces to investigate structural problems linked to the buildings and to understand the historical stratifications placed on the top of the pyroclastic ground floor tracing back to 79 AD. The drawing up of a plano-altimetric survey has been essential to understand the difficult relation between the dimensions of the current building and that one we are discovering.(figs. 4-7). The knowledge of the archaeological materials through analytical investigations supplied a great contribution to the investigations of the raw materials, on the place of discovery and the working techniques to distinguish places and production chronology and to better recognise their origins. The most part of the materials (frescoes, metals, mortar, stony, ceramics) especially the painted surfaces, whose preservation requires special attention, have been analysed. As regards the analyses of the many and well preserved metals, particularly the bronze, it was necessary to establish their origins, because of the extraordinary constructive planning using materials not belonging to the area.[5] The study has been extended to the skeletal remains of about 1000 individuals, 600 adults and 400 sub-adults, found in the Crypts. It has been made an anthropological and paleo-pathological study on these remains by the lab of Archaeo-anthropology of the archaeological Superintendence, Fine Arts, and Landscape for the metropolitan city of Florence, Pistoia and Prato. The results of the study are very interesting, they show signs of surgeries to divide the skull from the spinal column, that suggests the hypothesis of interest

[4] As regards the architectural survey of the hypogea and the church it's worth mentioning the collaboration with the designer Stefano Mazzacano and the plano-altimetric survey by the surveyor Massimo Santoro.

[5] As regards the material analysis it's worth mentioning the diagnostic activity about the mortars of the opus reticolatum masonry structure, the metal finds and the glazed oil lamp in collaboration with Dipartimento di Ingegneria Civile, Edile e Ambientale (ICEA), Dip. di Geoscienze e del Dip. dei Beni Culturali dell'Università degli studi di Padova represented by Ivana Angelini, Michele Secco, Anna Addis, Gilberto Artioli, Gregorio Dal Sasso, Caterina Canovaro.

in studying the brain.[6] The underground structures destined by vocation to host MAR Positano are located in spaces at different levels under the Main Church: the first structure, larger and more articulated, is on the left part of the church where the current oratory is; the other one is below the dome and apse area (see the graphic tables of the architectural relief). This area covers about 338,70 m² of surface that will be used for the museum. As they were extensively modified during the centuries, they destination of burial place is only the last of their uses. Today the MAR is the result of the work of Positano's Municipal Administration, of the collaboration with the Municipal Technical Office, of a project of research and synergy among the authorities (Regione Campania, Superintendence,[7] Research Institutes) and among professionals (archaeologist, architect, anthropologist, restorer, chemist, construction workers, etc.).

The medieval Hypogeum between Santa Maria Assunta Church and the Roman villa.

The awareness of the presence of the Roman residence has never been lost, to the point that portions of it have been reused over the centuries for the building of religious constructions (or places) like the medieval crypt located under the apse of the Main Church, but also to adorn the public spaces like the columns located in Piazza Flavio Gioia or those ones overlooking the sandy shore. As Karl Weber says in 1758 or Errico Talamo writes about the Temple of Pasitea in his Monografia della citta di Positano, "In a basement along the shores of the river in the marine contrada, you can see through a hole, that is currently closed, the remains of Pasitea's temple in reticular buildings and peristyle", or when he talks about the floods, "In the ancient past it is believed incredible floods happened, that, dragging a huge lapillus mass down from the mountains, had buried the lower part of the town, that goes from the Church of Rosario to the parish Church, and had picked the soil up, that was a flat plain till the sea. The buried buildings confirm this idea". The discovery place of this piece of the Roman art and architecture is exactly in the large space of the hypogeum, located below the eighteenth-century Church of the Oratory. This crypt is composed of two longitudinal spaces: the first rectangular-shaped one (5,60 m x11,30 m) hosts the excavation of the Roman villa, and is characterised by an apse (max wide 5,10 m) and three archivolt passages on squared corridors (2,70x2,50m) that link it to a secondary long and narrow space (17,70 m x 2, 80m-h max 2,73 m) with barrel vaults (table 9). This space, characterised by masonry tubs, previously ossuary, reflects the shape of the lateral nave of the above Main Church: on the east end there are two squared spaces (2,35x2,91 m 3,36x2,96 m) while on the west there is a passage toward Piazza F. Gioia, that is directly linked to the hall. The architectonic shape of this space let us think about the original function of it as well as about the probable relations with the famous settlement of the Benedictine Monastery of Santa Maria Assunta, that was founded in the Early Middle Ages. It confirms what Talamo stated in 1890 about the location of the monastery where the Church oratory currently is. Along the walls of both the main room and the passage corridors there are 65 very well accomplished burial masonry seats (fig. 5). After taking the skeletal remains away from the hypogeum, the location has been used to store a sizeable amass of things for 30 years. (figs. 6-12). The crypt wall surface shows a lime whitewashing finishing with red stripes on the shutter and on the archivolt; the barrel roof is lowered at a height of 4,95m; on the south-west side the same room is delimited by a wall opened with an archivolt gap. On the opposite side, to the south of the apse, there is a secondary entry to a room from which you can go up until the side entrance of the Main Church, through a difference in height of 3,25 m of stairs. The conservation interventions have been made to all the surfaces to achieve an aesthetic balance of the rooms in order to show their history. Thus the reconstruction of some pieces on the masonry seats and on other vertical surfaces proved to be particularly demanding because of

[6] As regards anthropological and paleo-pathological study of the skeletal remains made by Laboratorio di Archeo-antropologia della Soprintendenza Archeologia, Belle Arti e Paesaggio per la città metropolitana di Firenze e le province di Pistoia e Prato directed by Doc. Elsa Pacciani and requested by Positano's Amministrazione Comunale see the chapter about the diagnostics for the knowledge and preservation of the cultural heritage.

[7] It's worth mentioning the intense institutional and scientific activity by the Superintendent Adele Campanelli.

the gaps that prevent the restorer from having an overall view. Besides the Roman villa another barrel roof location of 5.50x4,50 m and 3,4 m high was found, the latter has a confused finishing masonry alloyed through strong mortar, lime and pumice layers, moreover there are burial seats along the 4 sides and a medieval well in the middle. The space under examination, corresponds with the above central nave of the Assunta Church, to which it is linked by a trapdoor

that has been reopened by positioning a thermal glass that allows an internal view from the respective rooms. The burial place was full of building material probably left there during the adjustment interventions of the Main Church as the many 18th cent. majolica fragments suggest. More than 45 18th cent. majolica boxes, many skeletal remains, with grave goods tracing back between the 16th and 19th cent., two levels of drainers, a 7,30m deep (after taking the pumice away) well in the middle of the medieval room, medieval red bands ceramics came out from the archaeological excavation. This space was originally obtained through the removal of pyroclastic material that is the high part of the religious structure on the north side and goes up until the shutter of the barrel roof covering the location. During the archaeological survey together with the discovery of this space, already mentioned in the parish dead book as the burial place of the *Confraternita dei Morti*, another smaller burial room came out on the east side. It was separated by a thin wall, and should be the *Annunciation's* one; it is 3,34x2,20 m large and 2,30 m high, with no burial seats. Agreeing with the authorities, the cognitive investigation survey of the archaeological excavation has been extended to the other parts of the construction site, because of the continuous finding of rooms, materials of priceless historic value. The load-bearing structure of the monastic complex of the Main Church is characterized by a chaotic stone wall with re-used material from Roman or medieval period and alloyed by abundant lime and covered by a thick lime and pumice surface (fig. 13). The most amazing archaeological discovery during the whole excavation campaign between 2003 and 2006 was absolutely the finding of the 1st cent. BC Roman villa that is located in the main room of the old cemetery below the Oratory Church and that was destroyed by Vesuvius eruption in 79 AD, when the pyroclastic materials and its meteorites demolished the build-up area in the valley. The discovery of the first findings directed by the *Soprintendenza Archeologica di Salerno e Avellino* occurred in 2003. It was the finding of the spaces left by the wooden beams inside the pyroclastic deposit (of which was made a plaster cast) and of a yellow tuff masonry part in *opus reticolatum*, where it appeared a first part of the amazing fresco. For the first two metres the excavation removed the pyroclastic covering irregularly the remains of the Roman villa. The long walls of the excavation have been subjected to propping that was not related to the Roman masonry, except from a *opus reticolatum* wall section above the frescoed surface which showed a clear structural kinematic mechanism of overturning due to the destroying action of the flood. Since the first moments of the excavation the villa walls let us enjoy the frescoes and their original colourful material, perfectly preserved thanks to the lapillus and ash coverage. The first discovered frescoes were well preserved, they only showed signs due to the eruptive lapillus and pumice impact and flow on the light blue surface painted through azzurrite, Egyptian blue or frit from Alexandria. The subjects on these frescoes are plaster bas-rilieves (cherubs, seahorses, dolphins) stylistically belonging to the late 3rd early 4th Pompeian style. Currently, starting from the crypt trampling dimension there are the wooden beams covering a collapsed ceiling, the yellow tuff *opus reticolatum* structures (dimension of the tronco pyramidal tuffs 9x9 cm, 13,5 cm high, the wall thickness about 48 cm), the bricks roof, two frescoed walls: the north one is about 5,75 m, the east one more than

Fig. 5
Burial seats placed in the intermediate spaces between the south corridor and the big room of the upper Crypt.

Figs. 6-12
Photos of the upper Crypt before the 2003/06 works. You can see the room conditions after the removal of the building materials showing the walled up passage to Piazza F. Gioia used as division from the Enel room still working till May 2006.

4 m, that must have been a 7,14 long wall according to the composition scheme of the painting. Only the north-west corner of the third wall on the west side is preserved, the most part of it was found fragmented during the works of excavation, and it has been put together and located on a new support now for the future exhibition. On the east wall you can see the cutting action of the flood mud, that has moved the upper part of the wall 2 m ahead, as it clearly shows the interruption of the decoration, that is visible again after 35 cm.

Fig. 13
Upper Crypt - Medieval mosaic elements included into the masonry intrados of the passage gap in the apse of the upper crypt.

During the works on the north front, in the not frescoed areas, it was necessary the propping to limit the instability of the Roman masonry structure and the excavation fronts made of heterogeneous/irregular materials and strongly stressed by the above foundation structures of the Main Church. The wide crack pattern of the masonry structure walls required significant assembly and repositioning of the numerous frescoes fragments, that were collapsed or collapsing because of some masonry sections crushing and the plaster crumbling of the painted surfaces.[8] There is a big overturned portion of the south wall covered by painted plaster as a proof of the existence of other painted rooms. Thanks to the materials deposit on the south excavation wall, we can easily notice, starting from the mosaic walkway, flood mud mixed with pyroclastic material and many frescoes fragments, objects, masonry pieces, among which a part of a column; pyroclastic mud with some empty spaces due to the previous presence of wooden elements, roof bricks, melted pumice of different fill material and between 1,5 and 2,5 m thick, that was firstly covered by the ash and then by the last solid pyroclastic layer sealing the Roman villa and rearranging the area orography. (figs. 14-19). At the end of 2005 there was a delay of the excavation because of its fronts instability, that were seriously damaged by thick solid pyroclastic (thickness range from 1 to 2 m) and melted pumice (from 1,5 to 2,5 m). The pyroclastic flow decreasing due to the slippage of the melted pyroclastic material toward the excavation area caused the progressive interruption of the pyroclastic deposit. For this reason it was necessary to make the pyroclastic material more stable through the injection of potassium silicate and nano-molecules of calcium hydroxide.[9] This intervention was complemented where necessary, by consolidation works with natural hydraulic lime. All these interventions were successfully completed in 2007, creating a compact pumice layer that ensured a perfectly vertical excavation front. Then on this area there have been other consolidation works using injection mortar made of natural hydraulic lime and an inox rebar to make the whole more resistant. Before excavating the part of the Roman villa inside the medieval underground room, a perimeter consolidation was made to ensure the fronts securing and unload the weight of the above religious structures on the foundation floor of the villa and not to weigh on the Roman walls. The structural relation between the monumental complex of Santa Maria Assunta Church and the Roman villa is mediated by the pyroclastic deposit, that has been shaped to create the vertical partitions of the underground space where the church building lays. The foundation of the near Bell Tower as well as the underground spaces lay on the flood-pyroclastic deposit from 79 AD and their masonry planimetry turns about 14°. Currently a technical room and its front space have been made, where you can read a brief report of the site discovery and enhancement works.[10] Two significant parts of the walls and the py-

[8] The architectural restoration works have been made by the "Teknodomus Restauri" srl from Poggiomarino-Napoli while the historical-artistic and archaeological ones by the restorer Adele Cecchini from Roma.

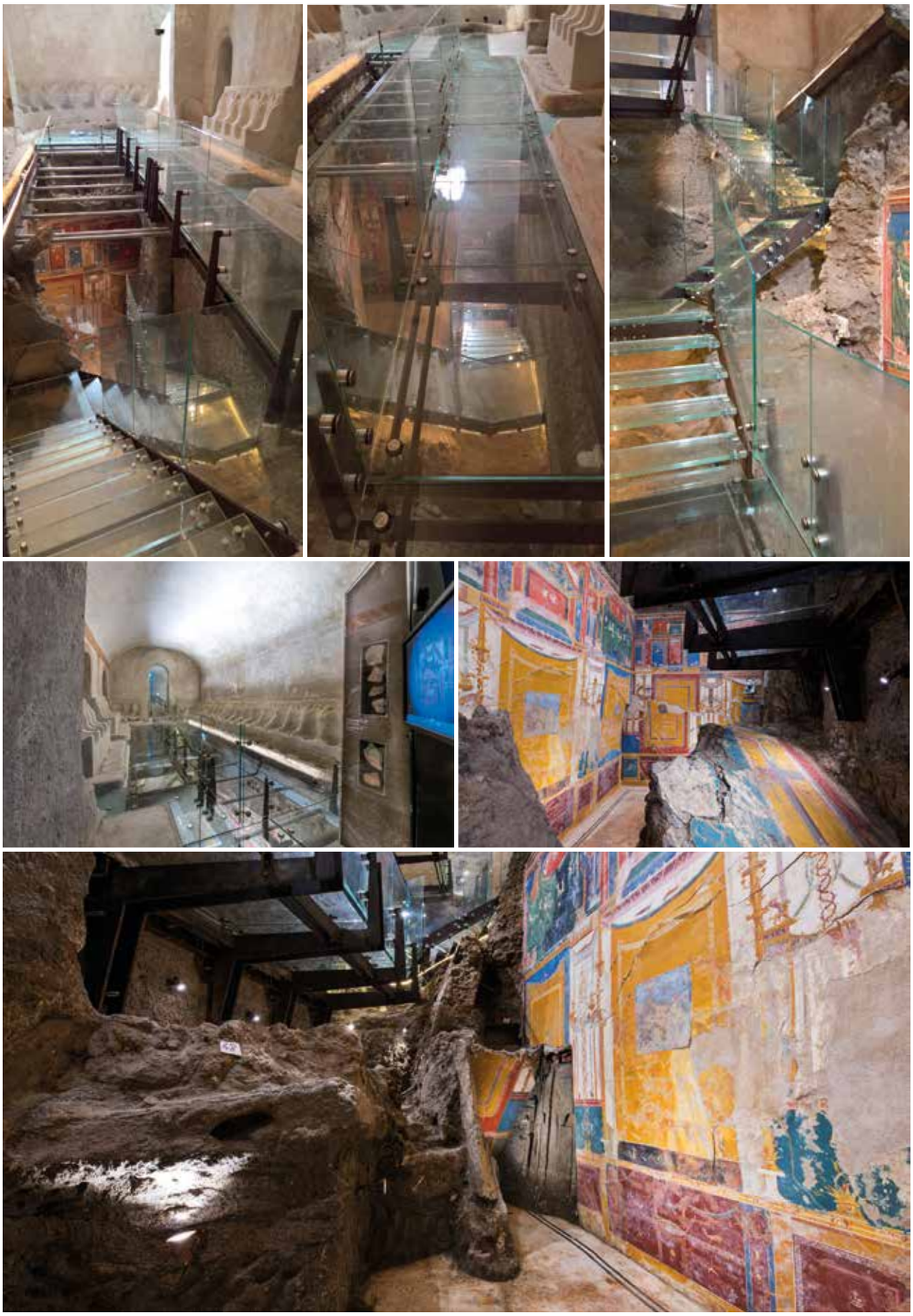
[9] The consolidation work was made by Giancarlo Napoli's restoration company in 2007.

[10] The architectural restoration works were made by "Antonio Pompa" srl and by Brigante Engineering srl between 2014 and 2017. The historical-artistic and archaeological works were made by Coo.Be.C. Soc.Coop. represented by the following restorers: Bruno Roberto Bruni (Technical Director), Angela Foti (site manager), Cinzia Loreti, Giancarlo Sorcini, Andrea Crisafulli, Patrizia Mariani, Emanuele Perugini, Silvia Mastrogiovanni, Francesco Angelucci e Giancarlo Epifani. The restoration of the ar-

roclastic deposit were excavated to supply an entrance compliant with the standards and an elevator to overcome the architectonic barriers. It was realized a metallic carpentry to support the slap of the above public ladder and the structure perimeter thrusts. Both the light calcareous stone ladder and the elevator for handicap visitors give the chance to go easily beyond the 2,30 m difference between the Piazza and the crypt. This space surface has been finished according to the same aesthetic style as the crypt simplifying the lime preparation covering all the other surfaces. After the excavation and finding works, a cantilevered Corten stainless steel and extra clear tempered/stratified glass walkway with a parapet has been created that is located just before the excavation area to let people enjoy the excavation site and the frescoed walls, where you can access through a ladder that goes 3 m down from the upper part to the mosaic floor of the Roman villa.[11] The walkway and the Corten steel and extraclear glass ladder allow a very good view for the understanding of the architectonic stratification: the ladder was purposely aligned to the layout of the Roman villa and was anchored to the pyroclastic deposit in four points without interfering with the archaeological asset. The walkway structure with parapet and trampling is made up of A type corten steel plates 15 mm / 20 mm thick and tempered/ SGP laminated glass connected through AISI 316 stainless steel struts. The structure is made up of pairs of shelves composed of metal plates, that are cutting cantilevered placed on the excavation and of a secondary structure composed of pairs of plates that connect them. The connection is through an AISI 304 stainless steel bolting. The walkway load-bearing structure is anchored to HEA 260 steel profiles. The latter are constrained to 3 concrete beams, which extend along the South corridor for a depth of about 4.70 m. The cantilevered part is 2127 mm and is made of pairs of tapered plates 15 mm thick and between 260 mm and 130 mm high. The shelves are connected with a double row of beam-shaped plates, the outermost is 110 mm and the internal one 170 mm high. The development, in the main direction is 10.24 m while the structure covers about 1.20 m. The walkway is connected to the museum apse area where the glass trampling goes on and it lays on the contrasting struts of the archaeological excavation walls. On the archaeological excavation fronts at about -70 cm from the crypt floor were placed some AISI 316 stainless steel struts through 200x200x10 mm thrust plates anchored to the stainless steel perimeter stringing, equipped with stainless steel and bronze guide bushings thruster system with frontal turning for chamber and thrust bearing, the bronze 50 mm diameter bush compartment with locking nut, and a trapezoidal threaded 50 mm diameter, 400 mm long bar for the plate frontal thrust. External 118 mm and internal 90 mm diameters pipes have been used for the struts placed in the apse as they are the bearing beams of its glass floor. 73 mm external diameter and 10.3 mm thick trusts were placed to give stability to the whole excavation perimeter in the main area; they were placed within 1 m apart from each other and were equipped with end plates and thrust system with trapezoidal threaded 30 mm diameter bar. Their action was exerted on a 250 mm UPN profile stainless steel perimeter stringing, 10 mm thick, which was in turn connected to the pyroclastic deposit through 24 mm diameter stainless steel bars, 2.5 m long, injected with natural hydraulic lime. The main structure of the staircase is made up of corten steel stringers, 20 mm thick, to which are anchored both the steps (three 10 mm tempered/stratified extraclear glass slabs with non-slip surface) and the AISI 316 stainless steel struts parapets. The staircase is composed of three ramps of different length, two landings and a balcony about 3m long, placed at lower altitude. On the whole the altitude exceeds about 4.00 m, and the longitude is about 9 m and the ramps are about 1.20 m wide. Parapets of staircase and balcony have been made of tempered and stratified with safety rigid plastic glazing glass to allow a perfect and safe view. The structure of the staircase is connected to the walls of cinerite by direct and indirect foundations consisting of lightweight concrete elements linked to 80 mm diameter micropoles (tie-struts), armed with 24 mm stainless steel bars. The steps and the remain-

chaeolgical finds was made by the restorers Bruno Roberto Bruni, Angela Foti, Cinzia Loreti, Giancarlo Sorcini and Andrea Crisafulli monitored by the Superintendence restorer Valter Tuccino.

[11] The structure calculation was made in collaboration with the engineer Michele Vignola who was the operations manager of the structural works.



Figs. 14-19
Photos of the archaeological excavation and the corten steel and glass structures made for the museum itinerary of the area.
(Pic. 17-18-19 by Vito Fusco, Arkimedia Lab)

ing floor area have the proper features to make the frescoes walls and mosaic floor path safe. The stairs end on a cantilevered corten steel structure equipped with walking level and glass parapet, anchored to the pyroclastic wall through tie and struts, where you can see the discovered *triclinium*. The archaeologist was supported by the restorers during the findings procedures so to guarantee the continuity of the preservative process and the interventions success. Considering the above it has been made an articulated museum path that is able to give value to the great historic, artistic, and archaeological context. The exhibition of the findings found in both the medieval space site and the archaeological one starts from the raised floor of the ossuaries laid in the corridor on the south side of the crypt; it goes on then in the location where you can see the medieval well by looking downwards, and the Main Church central nave by looking upwards through a crystal clear trapdoor in the keystone. In the same location an educational audio-visual is projected thanks to the depth of a next burial space. The archaeological exhibition goes on along the whole corridor and ends in the rooms opposite to the hall. After seeing the archaeological findings and the medieval hypogeum, going through a lintel-space characterized by plastic burial seats you can enter the big room of the crypt, where the archaeological excavation of the Roman villa is. The path goes on through a cantilevered walkway that enables to read the architectonic stratification (figs. 9/10/11). The location, frescoes and mosaic floor view is possible thanks to a progressive downward 4 m drop through the above-mentioned ladder and a glass and steel balcony, both of them anchored to the pyroclasticdeposit and not laying on the excavation level.[12] The findings exhibition are shown in specific showcases and multimedia videos, displaying the finding, survey and restoration account. Architecture, Pompeian IV style wall paintings, precious metals, fine glazed ceramics can be seen in their original context, referring to aristocratic and erudite clients, to their architects, artists and their workers, who were able to make a very elegant and splendid residence, perfectly immersed in Positano's incomparable landscape. You can notice a careful selection of the materials as well as the executive techniques, for example roof bricks probably imported from Lazio, the yellow tuff fence from Phlegraean area, the use of the pyroclastic material for the masonry mortar and of the plaster for the frescoes. Everything from the frescoed walls to the mosaic floor are proof of the planning and the work regardless of the logistic problems. It's worth underlining the brick pitched-roofs characterizing Positano's 2000 years-old landscape, that can be appreciated thanks to the dimension of both tiles and imbrexes and wooden beams. The tiles are rectangular (fig. 20) and about 46 cm wide and 60 cm long, their 4,5 cm wings, placed on the two ends of the longer side, have a 7/9 cm joint connecting the upper and lower tiles. The imbrexes are inserted in each pair of tiles through light mortars made of lime and pumice. They are tapered, whose radius goes from 18 cm to 14 cm on a whole length of 54 cm. The tiles were arranged in parallel rows on the roof, and overlapped on each other for 16 cm to avoid the rain intrusion and rise. For the Archaeological Museum, where the number of visits is essential to decide the type of system, was used a home automation system with remote control, aiming at checking the site safeguard remotely and limiting the operating costs.[13] The Led lightning system with warm colour temperature of 3000 k is equipped with a series of occupancy sensor that make groups of lights time-based turning on and off along the museum path in order to emphasize particularly interesting location details and findings. The frescoed walls are time-based enlightened according to the presence of visitors to avoid the continuous irradiation of the painting and additional heat input. The understanding of the hypogeum, the bell tower and the Roman villa meant the understanding of the monumental structure of the Main Church and its architectonic modifications hiding the past: for example the central nave interior has a barrel-vaulted wooden structure hung from the old beams of the roof today, or the 1927 façade (figs. 21-

[12] The stress test useful for the static test of the structures were made by the engineer Antonio D'Imperio from the "Laboratorio Ufficiale di prove materiali e strutture del Dipartimento di Ingegneria Civile dell'Università degli Studi di Salerno" (Practical-Test certify n.160079-80).

[13] The building automation system of the technological plants with remote check was managed by the engineer Salvatore Garzia.

22) hiding the previous late-baroque one.[14] Santa Maria Assunta church has a three-naved basilical plan (23,84 wide, 36,57 long), whose central nave is the widest and highest (13,50 m high, 9,40 wide), the side ones (7,76 m high, 3,27 m wide), the latter divided from each other by two round arches rows (five on each side), resting on quadrangular columns, not emerging transept; polygonal apse, flanked by lateral quadrangular chapels. The dome is supported at the intersection of the central nave and the transept on a high tambour. Four chapels equipped with a marble altar open outwards along aisles on both the south and north sides. The central nave covered by a false plaster barrel vault made up of a wooden equilateral arches structure hung from wooden ties anchored to a wooden structure just below the lower stringer of the trussed roof. The intrados of the vaulted structure is divided into five bays each one equipped with four big plaster covered wood arches.The bearing structure at the barrel roof extrados allows to notice the original architectonic features of the religious building, that is made up of pilasters with ionic capitals decorated with piperno rock entablatures according to the original rich historical façade style. That is what Errico Talamo wrote at the end of 800' "the roof was supported by very thick beams with their piperno rocks on the side" (figs. 23-24-25). The church is today the outcome of several modifications and stratifications made in the 17th, 18th, 19th, 20th cent. It's worth citing the 1927 religious building modification among the other inconsistent ones, when Positano's immigrants returned from New York, a new higher façade was overlapped, exceeding about 3 m height the bell tower. During the intervention the projecting architectural models, decorating the church original façade, were removed (Capitals preserved in the church) and under-foundations in the upper crypt were made. On the right side base have been written the names of the designer and director of the works, that were finished in 1929, of the cut stone supplier, and the masonry worker, respectively Eng. V. Chioccarelli, D. Basile, N. Cenitore. This had hided the late-baroque style and wasted the composition balance, that has always complied with the dome, the bell tower and the previous façade of the Main Church. (see photo Daniele Esposito collection figs. 26-27). The superimposition of a new façade would mean removing it and replacing it with what had been previously removed but luckily preserved to give the church its aesthetical balance and immerge it in the landscape frame again as we can appreciate in

[14] The historic photos representing the church and the bell tower belong to Daniele Esposito Collection

Fig. 20
Detail of the roof original recess clay-bricks of the 1st cent. BC Roman villa.

Fig. 21
Vintage photo of the end of 19th cent. where you can see the original late-baroque architectural façade of the monumental complex of Santa Maria Assunta Church (photos collection by Daniele Esposito)

the vintage photos. Today the most important structures in the Main Church, like the dome pillars, are seriously damaged by a crack pattern, that has to be continuously monitored to intervene in limited areas without wasting the architectonic stratifications.

State of conservation of the cultural heritage: hypogeum and Roman villa

The special condition of the discovery and conservation of the materials belonging to Positano's archaeological Museum obliged to value, check and possibly correct the cultural heritage proper microclimate since the first day of excavation. Agree with the scientific professionals of the *Istituto Superiore del restauro di Roma* direct interventions on the painting were made to preserve the painting layer and its supports and make them more cohesive and to check their microclimate. The latter action had to both understand the hypogeum microclimate and keep the right conditions to preserve the paintings. Taking into account the monitoring activities the air-conditioning system was planned, it was necessary although the required parameters for the paintings preservation without workers and visitors are quite respected. The check of the thermo-hydrometric parameters is provided through a double system because the site is visited especially in summer, as a consequence the sudden temperature changes could affect the underground space leading to probable decay and the painting surface removal. The thermo-hydrometric instability could affect the painted surfaces preservation, that was proved during the works, when few degrees temperature variation or relative humidity in the range 90-75 % could quickly matte the paintings through whitish layers due to the calcium carbonate precipitation (immediately removed by the restorers). The removal has to be quick because of the layers nature to avoid carbonation that can make them adhere to the surface and create crusts. Taking into account all these preservative conditions the chosen working practices, microclimate check and temporary works have guaranteed the RH parameters and the requested temperature and CO_2 values since the 1st cent. BC frescoes were discovered. The preservation of the painting layer is quite good in spite of its fragile and exposed texture. The

parts where the painting layer is more damaged are those ones where the pyroclastic material mostly adhered "tearing off" some of the original pigment. The other part of the surface that was covered by melted pumice looks intact and cohesive. (figs. 28-29). The two plaster bas-relief cherubs look very well preserved, on their shoulder and wings you can see the internal small iron pivots but on the right hand of the room the painting surface is covered not only by pumice but also by ash and moister pyroclastic material. The higher water levels in this area obliged to analyse the preservation of the underground utilities below the excavation. On the outmost side of the area below the public road, at a 3,50 m depth from the walking level, the leak of a sewage drain, carrying a lot of organic and hydric effluent to the purifier, has been found and removed to avoid further water seepage. The water seal in the underground utilities without seepages from the external walking level is important to preserve the painting surfaces and avoid damages. As the findings preservation is strongly conditioned by the environment where they are found or preserved after the discovery, it was necessary a register of "emergency response" works made by the restorers that were always on the archaeological excavation. The environment optimization to preserve the findings was achieved thanks to a synergy of actions like monitoring, temporary works and the activities used to guarantee the microclimate stability. The type

Figs. 23-25
Photos of the wooden structure of the barrel vault overlooking the central nave of the Main Church and the original tuff structure made of a strong entablature and ionic capitals.

Figs. 26-27
Panoramic views of the monumental complex of Santa Maria Assunta Church before and after the façade 1927 construction (collection by Daniele Esposito).

of materials (frescoes, metals, glazed and not-glazed ceramics, wood, bones) and their specific preservation state obliged to use different preservation actions. The frescoes were preserved through several kind of activities: reinforcing the Main Church underpinning through armed hydraulic lime-based mortar injections; securing the excavation front stability through AISI 316 stainless steel struts and armed microinjections able to limit the same structural kinematic motion as that one made by the pyroclastic mud, which completely covered the Roman villa 2000 years ago. The air-conditioning system was turned on before finishing the works to level the thermo-hygrometric parameters off, that could be easily modified by the works. Indeed, the thermo-hygrometric parameters alteration causes both whitish layers and colour loss because of the progressive saline crystallization that strips the painting surface when it opposes to it. The frescoed surfaces are the diaphragm between the remerged triclinium space, the masonry, and the pyroclastic material that covers the portion of the villa, that stands behind the *triclinium* itself up to a height between 11 m and 20 m. It is necessary to monitor the fragile structural condition as well as the thermo-hygrometric one, on which is based the passivation of the degradation phenomena that can determine the partial or whole painting loss. Moreover, the painting surface has been strongly conditioned by the burial materials so much so that different conservative and exposure situations have been produced. Some frescoes areas broke off due to serious crack pattern where the masonry disconnected from the wall. Lastly, the masonry and covering collapse caused scrapings and impact damages in many parts of the surface. The right side of the *triclinium* walls, between the higher part of the north wall and the east one, was damaged by a structural kinematic motion because of the forces provoked by the pyroclastic material that destroyed and buried the illustrious Roman building. The observed structural damages make us understand how strong was the mud force which hit the area from the north, causing a traverse of few centimetres at the base, of 50 cm in the height and a partial overturning of the *opus reticolatum* walls overlooking the frescoed surface frame. The east wall was more se-

Figs. 28-29
Pyroclastic sedimentations that strongly influenced the preservation of the painted surface.

riously damaged, where a horizontal crack pattern makes the wall upper part 35 cm shifted to the south: The wall disconnection can be seen from the *triclinium* north/east corner at about 2,50m from the original mosaic walkway level through an irregular wall cut, that goes down to 1.70 m after about 4 m. Among the masonry parts that have been damaged and locked in semi-overturning condition, it is worth remembering the collapsed one at about 5 m from the mosaic *triclinium* walkway level, that stands after the frame of the north wall frescoes. These masonry sections were made safe through the armed (with stainless steel 8-16 mm bars) hydraulic lime mortar microinjections. It is necessary to state which and how many materials buried the villa and the happening chronology. The photos depicting what happened make us believe as follows: so much melted pumice (over the m^3/m^2) fell onto the villa roof that it collapsed and it was covered by a 20/30 cm thick ash, that was quickly covered in turn by flood pyroclastic mud, that filled up the empty spaces left by the structure collapse. (figs. 30-31-32). The timing and way through which the mud buried this villa part is the reason why the triclinium "survived" the disaster. So, the mud had firstly filled up the *triclinium*, going towards the north-east corner and depositing objects and furnishings (where have been found) and producing opposite thrusts to those ones pushing the retro-north and east walls, that endured even if strongly damaged. The pyroclastic mud meteoric rainfall coming from the mountains overlooking Positano and its impact can be inferred looking at the large crack pattern on the masonry structures and the masonry collapsed pieces in the dig. The rainfalls dragged material deposit to the valley, so modifying the orography that the urban centre as well as the Main Church rest on foundation over 10 m higher than that one on which the previous architectonic structures rested starting from 79 AD. The *triclinium* archaeological excavation, besides highlighting the frescoes, found a lot of furnishings showing the peculiarity of the site. The bronze and copper findings show a perfect preservation state, restrained mineralization and delimited cyclic erosion signs highlighted by the typical oxychlorides presence. This phenomenon has been noticed on the most part of the bronze and

Figs. 30-32
Images representing alluvial and pyroclastic deposit (melted pumice, alluvial ash and mud) that buried the 1st cent. Roman villa.

copper objects, which sometimes developed a galvanic erosion to the detriment of lower redox potential metal objects. During the excavation a great number of footprints came out on the wooden structures associated with iron and bronze elements. The findings restoration was very demanding because of the extremely hard pyroclastic concretion made of copper and iron oxides. Blocks of fitted together objects were found during the excavation, that have been then divided in a lab by using mechanic means like manual chisels and pneumatic micro chisels. The choice to move them to a restoration lab was wise both to recover the objects precisely and safely and to realize a micro excavation, that has been recorded through a 3D[15] survey of the objects before and after the excavation and restoration works (fig. 33). The objects were: a bronze situla with iron handle, a bronze foil jug with bronze alloy handle, a foil oenochoe with bronze alloy handle, two bronze foil cauldrons, a phiale with aries head bronze alloy handle, five copper pans, two bronze foil (a ternary copper alloy 11% Sn 14% Pb) legs of a piece of furniture, a bronze tripod in a big lead cist, three iron spades, a two hands iron sew, an oval marble weight with bronze handle, part of a millstone, a stone mortar, a small marble column and pillar, a big glazed terracotta oil lamp etc. The restored objects were cleaned through acrylic protective materials to remove the calcium-siliceous crusts after the cyclic erosion passivation through BTA and ethyl alcohol. Also on the mosaic floor of the painted room the destroying force of the flood mud provoked a few centimetres translation of the north wall masonry structure: the most part of the wall repositioning from the base caused a slight mosaic texture "tent" lifting deformation. Despite the devastating disaster that damaged the Roman villa in 79 AD the mosaic floor is almost intact. The floor is made of white limestone tesserae placed diagonally on the *triclinium* walls except from the perimeter to the frame ones (double row composed of 4 parallel to the walls black tesserae divided by 5 white tesserae rows) where the white tesserae on both sides are set in three parallel rows. The mosaic texture is well preserved and its tesserae are perfectly sealed by the lime that made them solid in the *triclinium* walkway level.

[15] See the scientific paper by A. Ascierto and S. Borrelli in the chapter "Diagnostics of the knowledge and preservation of the cultural heritage".

Monitoring and technological system

The most important monitoring activity is the environmental one that analyses and checks the macro and micro climate factors related to the space where the findings are located: these types of survey are essential to plan the interventions of restoration, maintenance and dimensioning of the plants, that have to guarantee the requested performance. The planned and long-term thermo-hygrometric parameters check and monitoring affect the artefacts preservation and allow to act in advance to limit alterations and materials decay. More than two and half centuries have been spent since Herculaneum and Pompeii archaeological discovery and many surveys and experimentations about the Roman wall paintings preservation have been run and a development of the outcomes, despite the errors and corrections, has been achieved, that obliges to be cautious in the materials experimentation and to choose "the minimum intervention" solution today. The latter is a conservative choice used to understand the features and the preservative condition of the painting surfaces, before identifying the proper preservation, enhancement and fruition strategies. This choice requires the true knowledge of the cultural heritage and context that can affect its preservation and of the intervention suitable for avoiding the surfaces and/or their masonry support decay. The minimum intervention is a complex of even more demanding works than the direct interventions, that are often irreversible by their nature and cause more decay due to the used material. The intervention on the macroclimate factors through the proper structures and systems can oppose the hidden problems that otherwise can cause irreversible damages to the painting preservation. So the direct interventions are considered only the last option to be chosen for the preservation. According to the restoration history restorers should cautiously think about the use of those products that seem to be the "miraculous" solution at a first glance, that are then the main cause of damage.

Fig. 33
3D survey of the case with objects found on the north-east corner of the triclinium during the micro-excavation made in the restoration lab.

The findings preservation can be achieved thanks to a synergy of factors in which a crucial role is performed by the functionality and management of the structural and environmental control systems. The crack pattern of the frescoed wall has been continuously monitored during the excavation (fig. 9). The structural monitoring was made through a mechanical deformometer, that highlighted irrelevant modifications without important deformation.[16] The type of the site, the findings preservation conditions, the relation between the Roman and the medieval constructive phases, obliged to monitor during both the excavation and the site opening to the visitors.(fig. 12). The microclimate conditions of the hypogeum with and without work in progress have been monitored during the excavation. The revealed data during the first campaign of works state the stability of the microclimate with only slight seasonal temperature variations, that don't affect negatively the fresco preservation. The measured microclimate shows constant 95 % R.H. values and it stands in temperatures ranging from 15°C to 19°C. between winter and summer but it can be influenced by several factors (extreme ventilation, lighting, temperature leap over 20°C, high CO_2 concentration). The best temperature for the stability of the climate conditions and consequently of the frescoes surface is about 17°C that avoids the surface condensation. Three sensors blocks[17] have been placed to record the painting surface preservation parameters (temperature, % R.H., CO_2 and Radon gas concentration, excavation bottom flooding, frescoes surface temperature) in three different areas of the hypogeum and excavation space. As regards the carbon oxide, CO_2 values over 550 ppm were established as threshold level both for the hypogeum and for the human health. An open building automation system,[18] able to adapt to the probable technological plants developments, was entrusted with the site and plants management and control. The intervention will be basically passive, that means the site will be as much as possible isolated from the thermo-hygrometric outside fluctuation. Today the microclimate monitoring system not only remote records the mentioned parameters, but it also turns on and off the machines used to refresh the hypogeum microclimate values. This aim can be achieved through proper behaviours synergy, that respect the room conditions. So it is necessary to establish rules about the maximum visitors entrances in order to reach a balance through slight parameters variation and few interventions by the plants. The Randon gas monitoring and mitigation at not over 300 Bq/mc levels is necessary both for the visitors and workers health. Both the monitoring system and the air handling unit will be checked through a GSM ADSL line for supervision and remote control. The technological system is organized as follows: closures/allocations=zoning, microclimate monitoring, air handling unit, Radon mitigation and monitoring, visitors entrances control. Some compartmentalisations with glass doors have been placed in the upper crypt to avoid strong thermo-hygrometric variations and to limit the big room thermo-hygrometric instability. This space in correspondence with the apse has a second exit on the public road alongside the Main Church lateral entrance, that goes up 3,25 mt from the walkway level of the crypt and it is used as emergency exit. For monitoring the findings and the structures preservation it was used a machine, that measures more points and/or areas through innovative and very precise sensors, that measure the distance and the angles by using laser.[19] The measurements are carried out without using prisms or target on the frescoes but only using the laser measure ability. When the monitoring was launched it was decided the number of points rather than the measurement regularity according to a more fragile areas map. The recorded data are sent to the check centre and the displacement diagrams are automatically processed and sent through alarms (sms/e-mail) if the physiological thresholds have been overcome. The solution

[16] Between 2006 and 2007 the structural monitoring was managed by the C.I.Be.C. of Facoltà d'Ingegneria-Università degli Studi di Napoli by the prof. Salvatore D'Agostino and the prof. Carlo Viggiani, who handled the geotechnical survey of the pyroclastic deposit on which the monumental complex of Maria Assunta Church lays.

[17] The environmental monitoring system called RnF was installed by "Extratechsrl", that measures Radon, Carbon dioxide, temperature and relative humidity in real time in three specific parts of the museum and sends the data to the portal (WMS-Cloud) in order to analyse, check and record the data and to manage the critical thresholds that turn on and off the plants.

[18] The building automation system equipped with remote control was managed by the engineer Salvatore Garzia.

[19] The LEICA automatic structural monitoring system TPS-GNSS was supplied and installed by "Boviarsrl" from Naples.

stands in a fixed automated Total Station placed on the site, that works continuously. After the beginning of the works a monitoring of the Radon gas concentration was arranged by ARPAC-CRR from Salerno, that measured the gas levels and its mitigation timing, according to the law in force (DLgs. 241/2000 s.m.i.) in order to guarantee the workers safety. Today the thermo-hygrometric values control stations measures the Radon concentration levels, that stands under 230Bq/mc contrary to the initial recorded conditions during the first campaign.

Medieval hypogeum – "Old Church"

Besides the medieval hypogeum, through which you can enter the Roman villa, there is another fine crypt, that is the old Early Middle Ages church remain, from before 12th cent, showing a walkway level 4,60 m under the Main Church. This second hypogeum structure is made of a 13,20x6,40 m rectangular structure and a semi-circular apse with a 5,20 m diameter plus the semi-circular volumes of the side apses, quite whole walled today. (fig. 10). The central apse is covered by two small cross vaults and the rectangular one by four barrel vaults. These spaces were divided by a curtain wall on which there was a door showing a REUSAGE column (see photo 2003/2006 Works Archive figs. 34-35-36-37). The structure has been strongly modified again and again since the ancient period. On both the partition and the right apse curve and from it till the central pillar there are masonry burial seats. (fig. 38).[20] So the crypt plant looks as follows: three aligned REUSAGE white marble columns in the central nucleus of the crypt and a pink granite column aligned with the central column on the east side, where the crypt apse area opens. On the east side of the apse wall there are plastic decorative elements, that make the wall look like a false stone. During the pastoral visits in the middle 16th cent. the Amalfi archbishops wrote about five altars placed in the crypt, of which one dedicated to the Nativity of Jesus Christ. This false stone wall make us believe the above mentioned altar was placed just in the crypt apse. In the south angle of the apse came out a small part of the original walkway level, made up of a mixture of pumices and lime. In this apse area three ancient entombments came out, that have been unfortunately reworked lately except from that one on the south side of the apse under the *putridarium*. The current crypt entrance is due to the absence of an access to the church, that obliged to open a gap in the apse in the late '60s, made of a walled up lancet window. The north and south naves are composed of two big moulded pillars, that are a reinforcement works bearing the dome construction, as you can see from the intrados crack of the north barrel vaults. This produced the blockage of the most part of the naves on both the sides and turned the hypogeum from liturgy sub-structure to crypt. Both the pillars have two marble Roman columns, that were the bearing elements of the crypt main structure. Aligned with the north nave there is a thirteen steps ladder, ending with a medieval carved marble bonnet; this passage was used to access the upper church between the two dome north pillars. (fig. 39). On a pillar on the west side before the north nave there is a very bad preserved fresco decoration fragment that has been restored during the works. In this space a dividing wall was removed, the masonry pillars were excavated to highlight the two Roman marble columns then used to make the naves and placed in the masonry used for the dome pillars underpinning. On the south side of the crypt main structure was found, at a higher level, a squared- shaped space used as burial of the upper church and linked to it through a very small hatch. From this burial space, placed two metres under the crypt walkway level, we can easily see the vertical outline of the original medieval façade. The burial space has been obtained from the excavation of the two aligned masonries: on the crypt structural boundary you can see its outline that is perfectly vertical to the original lime and pumice plaster finishing that excludes the development of another nave on the south. Moreover the walled up lancet window on the south side of the nave suggests us the context of the religious building original structure. During the excavation of this burial place significant lime and pumice mortar plastered and painted plaster decorated fragments have been found. (fig. 40). It's worth mentioning

[20] See the photo by Giulio Rispoli/Archive Capodanno of the burial seats placed between the apse and the naves with the last deceased burial.

Figs. 34-36
Lower Crypt- view of the apse before the 2003/2006 works divided from the naves through a masonry wall including a Roman column that bears the hypogeum vaults.

Fig. 37
Lower Crypt- detail of a medieval column model decorating the medieval hypogeum originally.

among the remains the Solomonic masonry and plaster column, that is at the entrance of the side apse, that traces back to 12th cent. and represents the decoration of the pillar (fig. 37) The pillar goes towards N/N-E through a slight sweep that shows another small apse cut by the old covered stairs in via Rampa Teglia. Respecting the symmetry the same decorative element and a side apse must be also on the south pillar. On the north side of the crypt main structure in correspondence with the north transept of the above church, came out the final part of the staircase accessing to the above church after the removal of the medieval marble headstone closing the ancient access. At the end of the above mentioned staircase the screed of the medieval marble inlaid floor mosaic has been found. On the screed there are clear geometric, rhomboid and rectangular tracks related to the 12th cent. mosaic tesserae housing (fig. 41). This space was lighted by 3000K floor recessing led lighting. In correspondence with the two central naves two multimedia stations have been placed to project didactic videos. The preservative and aesthetic interventions allowed the restoration of the original plasters in spite of preserving the stratification, as it is also clear from the intervention on the pillars used for the dome construction, that don't have finishing as the other hypogeum surfaces. (figs. 42-50) According to the original floor it has been reproduced a mixture of lime showing chromatic features similar to the original ones but using hydraulic binders for a major usage resistance.

The mixture has been consolidated and processed in surface water-repellent products to make the maintenance easier. It has been arranged an air-conditioning system able to guarantee both the preservation and the thermo-hygrometric environmental conditions to make the hypogeum usable during the visits.

The museum itinerary

It starts from the external ticket office placed near the bell tower where people begin their tour then it goes on towards the church yard where the visit is described and the urban-fabric history told. The guided visit lasts about 30 minutes and offers a historic

viewpoint over the places in order to recall backwards the history of the precious Roman villa dating back to 1st cent. BC. The museum itinerary from Santa Maria Assunta church yard, through the Main Church (respecting the liturgical functions), or through vico Vito Savino and the flight of steps on the north side of the church goes to the medieval hypogeum called "old Church" before and then goes on to the hypogeum where the archaeological remain of the Roman villa is. The passage in the lower crypt shows a first example of the site stratification that gives the visitors a historical and territorial overview of the cultural heritage thanks to the guide explanation and a brief video. The itinerary goes on towards the upper crypt through an access on the north side of the bell tower: Here in the entrance, on the left side, after travelling along the stone stairs descending to the crypt, there is a construction site devoted area and a space closed by a sliding door, used to collect machines and the controls of site technological systems. In the entrance hall there is an elevator for disabled people. Aligned with the entrance door there is the glazed oil lamp, that is visible also during the museum closing time at night. In correspondence with the entrance, some didactic panels display the site, the finds and the site restoration and the musealization ideas. The general lighting of the medieval space is ensured by luminous bodies, hidden or shielded to reduce the perception of foreign elements to the site. The entrance is enlightened by lighting elements able to show the space gradually and to highlight the several interest points of the visit. Through a side passage delimited by a glass door, you can go from the entrance area to the south corridor where the crypt is displayed thanks to didactic panels and skeletal remains and grave goods showcases. After this first display section that uses as cases the tubs once used as ossuaries, on the left side there are the burial seats and on the right side there is the gap leading to the ancient burial place where you can see a medieval well through the glass walkway level. Aligned with the well you can see the vault intrados of the central nave looking upwards through the trap door glass closing that was formerly used to lower the corpses. The passage through this ancient and evocative burial place is combined with the projection of local vintage images and evocative sound. Floor recessing lighting and a corten steel and tempered extra-clear

Fig. 38
Photo of the burial seats placed between the apse and the naves with the last deceased burial. (photo by Giulio Rispoli/ Archivio Capodanno).

Fig. 39
Photo tracing back to the first archaeological campaign where you can see the passage ladder between the medieval hypogeum and the Main Church, that is closed by a carved marble slab.

Fig. 40
Photo of the plastered and painted masonry walls visible from the burial place located in correspondence with the south nave of the lower crypt.

glass structure let the visitors have a good view of the space strongly characterized by the *putridarium* along the walls. The archaeological remains starting from the masonry and plaster column portion of the *triclinium* are displayed in sequence along the south corridor. The itinerary goes on till the spaces opening at the bottom of the corridor. From the south corridor, through the arch vaulted intermediate spaces, you can walk the big room, where you can see the architectonic stratification and the features of the barrel vault room and its *putridaria* walking through the glass and corten walkway. The itinerary goes on through a corten steel and glass ladder towards the *triclinium*, where you can see the painting surfaces, the mosaic floor and the spatiality of the oldest Positano residence thanks to a suspended glass structure. The architectonic surfaces re-presentation respected the passing time signs that usually show the belonging era of each masonry work and as a consequence the past time. Due to both preservative and safety problems the exhibition spaces maximum capacity is 10 visitors per group. The museum is equipped with touch screen monitors and/or didactic videos.

The urban context: restoration, archaeological area expansion and protection works

Aesthetical-functional qualification works have been planned and made to extend the archaeological area and give value to the urban context: extra maintenance interventions have been made to re-present the walking trail that goes about 180 m from Piazza dei Mulini to Piazza F. Gioia descending at around -22 m of altitude and leading to the MAR Positano museum area characterized by hypogea and archaeological excavations.

Piazza Flavio Gioia

Besides the flooring, the underground utilities and

Fig. 41
Medieval mosaic intarsia found during the archaeological survey in the lower Crypt near the ladder linking to the Main Church.

Fig.42
Current floor closing hatch of the staircase leading to the lower crypt from Chiesa di Santa Maria Assunta. It is made of tempered glass and a stainless steel structure and characterised by a lime screed with colourful mosaic tesserae and it is completely independent from the perimeter masonry.

Figs. 43-50
Photo of the medieval hypogeum after the restoration (Pic. by Vito Fusco Arkimedia Lab).

the lighting drastic remake, a ramp for people with disabilities has been built, that links the piazza and the MAR museum to the church, that is in turn linked to the suitable for vehicles via dei Mulini through the side entrance. The piazza extra maintenance work was made according to the original plan by the artist Mimmo Paladino, replacing the weak lime and pumice flooring with the one made of photocatalytic hydraulic white binder characterized by selected inert and additives (Carrara white marble and black ebony). The mosaic by the artist has been restored to fill the gaps left by many mosaic tesserae. The fibre optic lighting has been replaced with directional led spotting lights (10°, 3000K colour temperature) to enlighten the flooring mosaic from above by direct beams with no loss of light. The piazza is enlightened by recessing wall led that are used on the stairs too. This type of lighting guarantee a discrete and wide downwards light distribution, it is relaxing but user-friendly at night as well.

Oratory Chapel

The third intervention area is the oratory chapel, home of the ancient "congrega della buona morte" in Positano, whose foundation date is uncertain. The historical sources state that the original home was the homonym chapel placed where the Main Church left nave, which was built together with the right one for the new church in 1777 but that caused its destruction, is currently. The new chapel was rebuilt at a slightly higher level by re-using the structures placed above the old abbey cemetery, next to the Main Church. After the last works an old polished lime and pumice door gap, on which the "Holy Ghost" was found. The same type of tonachino based on lime and pumice expands below the plastic divisions that characterizes the architectonic surfaces of the Oratory Church today. The Church is made of an only one barrel vaulted nave and a semi-circular apse housing a big wooden crucifix flanked by the figures of Saint Pietro and Saint Paolo. In the main entrance there is the choir and the pipe organ. The 18th century plasters appearance seems to deny the once existence of the choir that is made of a metal structure with HEA beams today. Instead, the vault paintings, mentioned by Talamo, and the wood stalls used during the brotherhood meetings, whose strongly damaged remains are preserved on the walls, have disappeared. The late 18th century front with its plaster compositions inspired by the original Main Church ones has been strongly simplified as regards the chromatic elements regardless of how the colours, like the antimony yellow heightening, could have intensified the façade architectonic plasticity. The room covers about 78 m² (max 14,83 long, 5,58 m wide, 5,58 m high). Finishes were in a very poor state of preservation and heavily painted whith significant and widespread phenomena of detachment. The buiding has a pavement in cement shot below which some assays have revealed a slab of lime. This space has the same perimeter of the underlying upper crypt where the 1st century frescoed architectonic structures have been found. The restoration evolved through three essential steps: recognizing the original style after the discovery of a paintings and colours palimpsest usable for the re-presentation; the plasters consolidation and their re-cohesion to the wall; the re-presentation that, respecting what emerged from the cleaning, preserved the same compositional and pictorial style of the plasters decorating the intrados of the Chapel nave as the original through a two-toned white reproducing the green striped marble. (figs. 51-55). The same type of intervention has been adopted for both the indoor and the outdoor architectonic surfaces where has been found a chromatic style that, far from being only a common paintwork, aims at highlighting the plastic idea of the architectonic front. The Led lighting was upwards directed using beam spotlights placed along the frame of the vault overlooking the space.

The Town Bell Tower of the Main Church

Simultaneously with the Crypts restoration, the bell tower has been restored because of the precarious preservation state particularly related to the cantonal crushing (fig. 56) during the 2004 works campaign. The bell tower is one of the most important architectonic features of Positano urban area. It is in the church yard, few steps from the facade of the Main Church and it is the refurbishment of an older structure. The author of the 18th century version (1707) was a Capuchin friar whose name is on a commemorative tombstone

currently walled-up on the external wall of the church in via Savino. The Bell Tower has a squared masonry structure (6,85x6,85 m) with four overlapping blocks and a cantonal total retreat 75 cm on a whole height of 23,50 m (tables 11-13). The openings, the hip rafters cantonal and the trablations are made of piperno and tuff. Over the south side entrance there is a walled-up medieval bas-relief representing a *pistrix*. This white marble plaque (90x235 cm) was on the Main Church floor (precisely in the Holy Sacrament Chapel, where Matteo Camera saw it as he writes in 1876) while the current location traces back to 1881, at the same time as the refurbishment of the bell tower that was modelled on the contemporary style. The current placement of the medieval plaque was decided in order to avoid damages due to the continuous footfall. The first to talk about the above bas-relief was Pansa who wrote about it in a work later published in 1724 (10). Bertaux published "*L'art dans l'Italie meridionale*" in 1903, where he shows the bas-relief through a photo tracing it back to 12th century because the *pistrix* on it is similar to that one in the mosaic of the older Ambon in Ravello Cathedral (first half of 12th cent), so he calls it "Ambon fragment". The vertical connection of the bell tower consists of a small gooseneck staircase for the two first levels, and by a metal carpentry staircase, that replaced a very badly preserved wood jack ladder on the next floors (figs. 57-58). The first and the last floor have a barrel vault roof while the intermediate ones have rib vaults. The archive docs gave useful information about the static conditions. The bell tower has been continuously restored since its construction. The most significant information related to the statics traces back to 23rd April 1758, when on the occasion of the excavations of the Roman villa of Positano, Karl Weber (officer of Pompeii, Herculaneum; and Stabia excavations under Charles III of Spain), during the excavation of the Roman villa in Positano ordered "to close and embed the first cave and the small stone and soil made rooms with three mortar pillars to bear the bell tower; it should be necessary to appoint two excavation experts of this real site, who together with the other four local experts could achieve this goal within 15 days". In the same document Weber, besides talking about his analyses of the Roman building next to the Church opposite the beach and at the bottom of St. Maria a Castelli and St. Angelo mountains at a 30 palms depth (7,93 m), reports the story, that was told him by the sacristan Giuseppe Vianiero, about the repeated excavations of ancient goods made at the end of 1600. The story also says part of those goods were later sold to St. Teresa nuns in Naples to make money to enlarge the Main Church.

In the area near the bell tower there are the remains of the Roman villa, that is no more accessible because of the modern waste stuff deposit and successive obliterations. The bell tower is located on a solid grey tuff piece where the base is about 80 cm under the footfall level. The structure was restored on initiative of the municipal authority between 1953 and 1963 to remove the clock and the *campaniletto*. In the archive database it wasn't described any crack pattern that was then discovered during the first works campaign, and later described in the documents about the first level of the cantonal. It was hard to observe the evolution in time because there wasn't a clear knowledge of the previous preservation state. It has been found a similarity between the "Sopraintendenza ai Monumenti della Campania di Napoli" and "Positano Municipal District" as regards the bell tower restoration works, consulting the historical archive of the "Sopraintendenza di Salerno e di Avellino" photographic reproduction dating. The data are about licences and authorisation that were necessary to restore the bell tower according to the municipal authority: the first doc traces back to 12th November 1952 and it states that the municipal district asked the superintendent Rusconi for £100.000. In 1954 the municipal district appointed the engineer Tutino Beniamino to plan the restoration: the paper is just a report dated 30th March 1954 describing before the preservation state of each front and then the necessary consolidation works. The engineer shows the necessity "to chain the walls of the last level down using iron chains or a reinforced concrete cage, to reconstruct the parapet in order to restore the crosses connecting them through a suitable reinforced concrete curb and to reinforce or remake the vault bearing the floor on the top level". The superintendent Rusconi asked for a more detailed plan", through a paper dated 1st April 1955, because

Fig. 51
Internal view of the Oratory Church before the restoration.

Figs. 52-53
Graphic detail on the original doorway located on the south side of the architectural structure of the Oratory Church.

Figs. 54-55
Internal view of the Oratory Church after the restoration and the re-presentation of the original chromatic features of the plasters on the nave surface.

Fig. 56
Detail of the Bell Tower south-west corner characterised by the crack of the tuff bricks before the 2004 consolidation works.

the previous one was too general. The paper dated 26th February 1962 by the mayor G. Vespoli to the "Soprintendenza ai monumenti della Campania di Napoli" is particularly interesting and states as follows: "referred to the bell tower restoration works, that are being made by the engineer Andrea Pansa company, this construction committee during the meeting on 20th February 1962, after considering the current works development, decided unanimously that the outer painting of the bell tower has to be the same as the prior one, that is provence rose lake coloured, as it is clear in the picture painted by Ettore Pignone del Carretto in 1936 and hung in the municipal district." This colour was also easily visible on the tuff masonry paintings. For deciding the plaster surface finishing was very useful a whitewashed old circular red plaster frame on the north front of the last level found after the removal of the mortar during the last restoration works in 1963. After the works on the bell tower campaign in 2003[21] it was noticed the absence of the chains or reinforced concrete cage mentioned in the 1960 plan paper, and the rubble masonry on the last level was made of squared tuff blocks and it is 1 m thick contrary to what mentioned in the 1960 plan paper. The pendentive vault of the last level didn't show any evidence of the consolidation work mentioned by the engineer in 1960 plan paper except from a hurried intrados propping through wooden elements. After the damaged mortar scarifying it was found out that the tuff crosses were immersed in a concrete crub at a 15/20 cm depth and the corona of the last level was made of cantilevered tuff bricks and reinforced concrete curbs (about 25 cm high) that appear cracked because of the metals oxidation. It has been made a detailed survey to better understand the multiple preservative problems of the town tower in order to supply reliable data for the spreadsheet. The planning choices took into account the outcomes of the FEM linear static analysis of the structure.

The bell tower shows the following features:

- Almost squared horizontal section with a 6,85 x 6,85 m lower plan and a 5,29 x 5,36 m upper one due to an overall retread between the two plans of about 0,75 m.

Figs. 57-58
Photo of the internal preservation state of the Bell Tower masonry structure before the 2004 consolidation works when the preservation state of the masonries, the ladder and the bell bearing structure came out.

- 23,50 m maximum height from the churchyard footfall level.
- Masonries variable thickness in a range from 2m on the ground floor to 1,625 m on the first floor and 1,33 m on the second floor and 1m on the third one.
- On the east side, from 0,00m to +2,30 m height, there is a reinforced concrete staircase that connects the porch and the public street while the bell tower is completely isolated from the other surrounding structures along the opposite side.
- The base is made of calcareous stones of remarkable size and lime and lapilli wich is about 10 cm from the

[21] It's worth mentioning the precious advices by the prof. arch. Salvatore di Pasquale and the collaboration with the engineer Michele Vignola.

above-ground masonry perimeter.

- The elevation walls have local calcareous stones structure chaotically placed with thick mortar (lime and lapilli) and a secondary structure made of squared piperno ashlars. The latter defines the cantonal ones (1,30 m x 1,30 m or 0,90 x 0,90 m), the entablatures, the cornices, the windows frames. The piperno bricks thickness range from 18cm to 45 cm and they are 1 m maximum high: the biggest ones are placed in the corners because of the major stress in this area that is generally more rigid than the walls. Although the considerable masonry thickness the several holes exclude a rubble masonry so it was adopted a HC (homogeneity coefficient) for the structural analyses.

In the bell tower there are two types of masonry, the first is made of stones chaotically placed and bonded together with abundant mortar, the second one is made of squared tuff bricks bonded together with a slight layer of mortar. So the masonries have a very different elastic modules look. Due to the imminent burden of the overlying load, the mortar vertical constractions over the tuff one, through an inverse relation of the elastic modules, cause inevitably the cantonal crack. The difference in the elastic modules certainly provoke the damage that has been noticed. The mortar and the stone are well bonded together except from the areas closer to the masonry outer surface that is not cohesive. The base state seemed to be quite good despite the advanced state of compaction of the bell tower on it. Based on the outcomes of the FEM linear static analysis it was possible to deduce the distribution of the state both quantitatively and qualitatively (fig. 59). The above results made us focus our attention mainly on the areas subjected to traction, given due the recorded reasonable compressive stress was 2kg/cm^2. The traction was concentrated on the top of the openings where a consolidation work was made through AISI stainless steel ties and anchor plates to contrast it. The consolidation developed through a stainless steel bars reinforced frame on the crack bricks, a hydraulic lime mortar grouting, the consolidation of the pendentive vaults through carbon fibre and epoxy resin, the replacement of the top bond-beam of the strongly oxidised reinforced concrete cornice with a reconstruction using NHL fibre reinforced grouting and a AISI 304 stainless steel bars frame. This reconstruction, in addition to reshaping the top moulding of the civic tower, made a reinforcement ring of the upper part of the structure. The same state of vertical loads was added to cyclic wind effects and the temperature variations that contributed to damage fatigue phenomena. Indeed, the surveys about the fatigue explain how cyclic stress can result in progressive and localized structural damage and the growth of cracks. So this stress state is not a physiological process rather it is an intrinsic characteristic of the structure. A damaged state is due to the fact that the masonry stress safety limits haven't been respected during both the planning and the execution. This refers to a remark about the traditional masonry features by S. Di Pasquale, who defines them as "belonging to an intermediate semifluid category, as some 18th century researchers wittily define them [...] the structural mechanics shares a lot of things with the flow plasticity theory". The structural analyses is necessary before planning the restoration. The structural and chemical analyses, if correct supplies essential information about the building construction evolution. It is worth remembering what A. Giuffrè writes about this issue: "The decay effects can't be studied without knowing the matrix which they affect" The decay effect as the characteristic behaviour of the structure can be considered as the outcome of a balance precarious condition developed during its construction or successive interventions. The historical analysis of the ancient buildings makes us understand how the so called " construction art" is important to their preservation. The only examination of the architectural past highlights the physiological or pathological behaviour of the old structure. Each civilization aimed at achieving the structural safety when it chose a specific construction technology. The safety and vulnerability of a structure are intrinsic conditions of each structure and the building preservation depends on their relation. The restoration of the town tower through the removal of many reinforced concrete reconstructions lead to the restoration of the piperno crosses merlons placed on the top of the bell tower, rescuing the damaged crosses and adding the missing ones. For the surfaces restoration have been used nat-

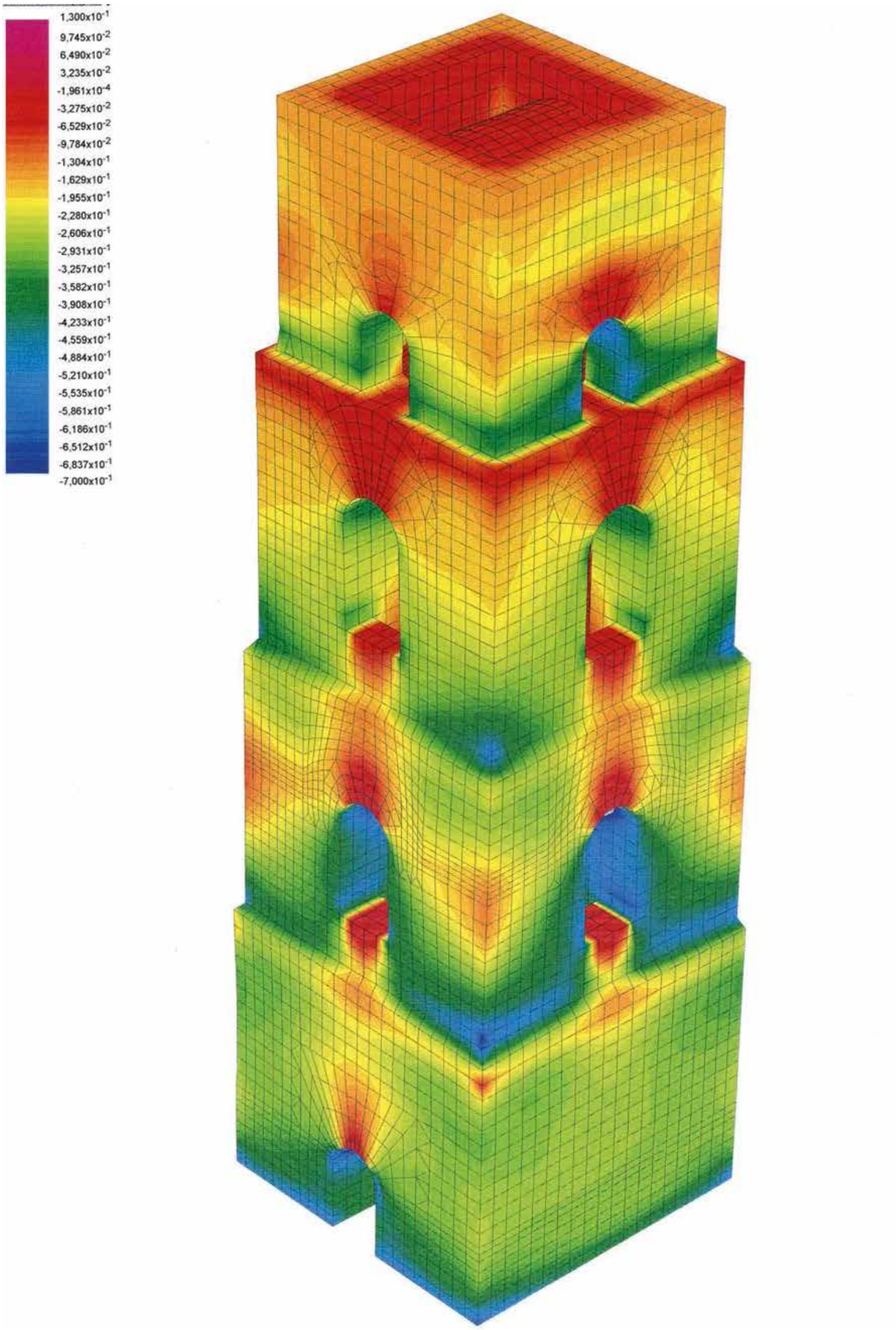


Fig. 59
Representation of the tensional stress distribution related to the minimum principal stress (the red areas represent the tensile stress) that came out from the structural analyses elaborated for the 2004 consolidation works.

ural hydraulic mortars and for the architectural fronts has been used an aerial lime-based plaster blended together with ebony black aggregate to get white linked to the precise geometric tuff compositions. The crumbling wood ladders have been replaced with galvanized white (the colour of the fronts) steel structural work. The previous concrete screed on planking level has been replaced with a natural hydraulic lime mixture. After the consolidation of the vaults through a concrete slab made of cementitious lime mortar embedded with a AISI 304 stainless steel frame (figs. 60-61) the paving refurbishment was started. The bell tower restoration was finished in 2005 when the interior and outer led lightning was implemented on the top of a motorised arm that comes out of the last level window at night enlightening downwards Piazza Flavio Gioia.

Future Prospects

The geo-archaeological survey by the "Soprintendenza Archeologica di Salerno e Avellino" allowed to locate a villa area larger than that one come out from the excavation up until now.[22] In this expansion prospect the via Rampa Teglia area is included, where an archaeological excavation has been started during the last works campaign, during which the area to be studied was consolidated through a stainless steel bars reinforced frame and a hydraulic lime mortar grouting to the depth of 13 m. It was necessary to make a no intermediate abutments deck supported by REP beams supplying light for about 13 m in order to make the area viable for pedestrian and accessible for vehicles. For the concreting operation has been used a ready-mix lightweight concrete. It was also necessary to refurbish the underground utilities that could affect the preservation of the underlying archaeological excavation because of the significant water and organic fluid loss. The clearing near the staircase has been remade using the same stones as those removed ones: in place of the previous 20 cm high steps and a large thread there is a uniform height and threads staircase today. The clay tiles roofs of the 1st century BC Roman villa and the underlying *opus reticulatum* frescoed walls have been found under the public area at the depth of about 5 m today (figs. 62-64). The intervention got further worse because of the terrible preservation state of the sewer channels and of the modern age and late antiquity burials. The archaeological excavation could be included in the programme of the cultural events that will increase the interest in the newborn MAR Museo Archeologico Romano di Positano. The medieval walled up materials and the 19th cent. ceramic and mortar aedicule were found through the same intervention. Seeing the reached outcomes it appears clear the beginning of an identification process of an archaeological area and of a museum where you can find and preserve a paradigmatic piece of the Roman villa. The site complexity and the bigger problems are related to those factors influencing each work, first of all the logistic aspect of transports. Therefore the reached outcomes are the result of a multidisciplinary discussion and a continuous interdisciplinary debate that lead to choose the proper restoration techniques to overcome the complex problems related to the site identity. The works have been finished with the planning of the figurative identity able to transmit and strengthen the idea of " Positano's Roman Archaelogical Museum". Regarding the logo it has been chosen the iconographic element that best influenced the collective memory in the last 10 years and that has been used in many scientific and journalistic articles: the seahorse and the architectonic structure where it lays on. This iconography linked to the acronym MAR (the name of the new museum) identifies the place where Positano's inhabitants keep the heritage of their most ancient and splendid past.

22 The geo-archaelogical survey was managed by the geologist Giovanni Di Maio and the Scientific Direction by the "Soprintendenza Archeologica di Salerno e Avellino"

Fig. 60
View of the Bell Tower after the 2003/06 restoration works.

Fig. 61
Internal view of the Bell Tower where you can notice the traditional use of lime and pumice mixtures to build floorings and staircases.

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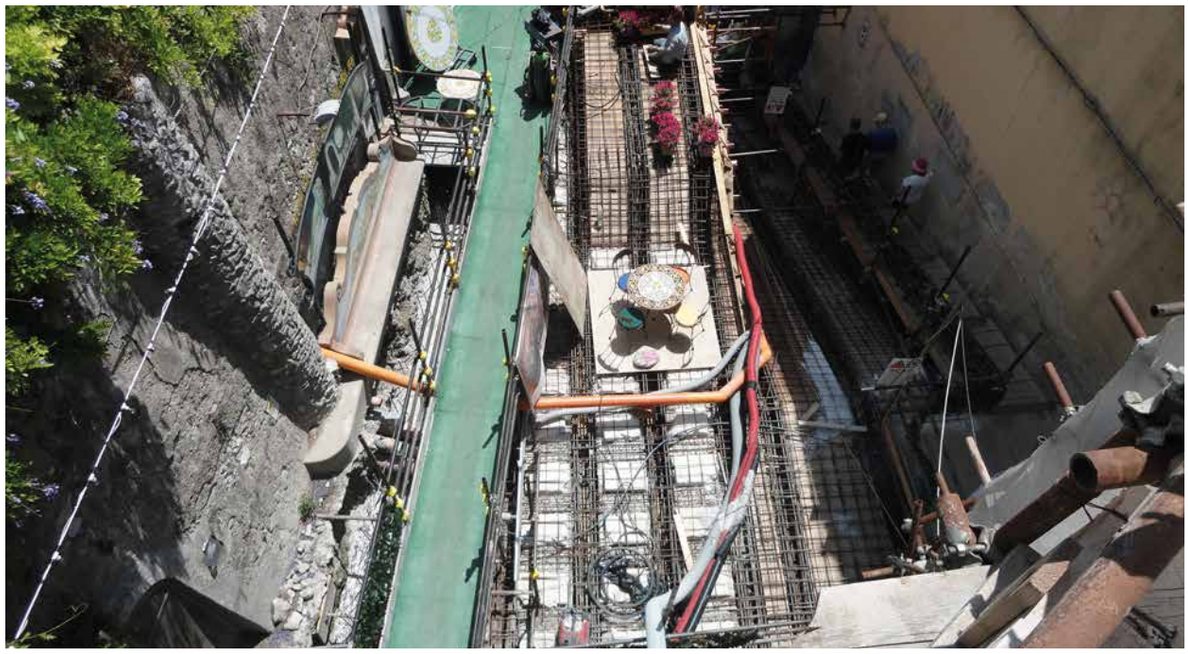


Fig. 62
Upper view of the structure roof protecting it from the municipal archaeological area on the north of the Main Church during the fitting of the beams.

Figs. 63-64
View of the archaeological excavation in via Rampa Teglia where the same burial conditions as the Roman villa were found.

Fig. 1
Plano-altimetric survey of the hypogea tracing back to 2006 equipped with the projection of the stucture of the above Santa Maria Assunta Church.

Fig. 2
Plano-altimetric survey of the Santa Maria Assunta Church tracing back to 2006.

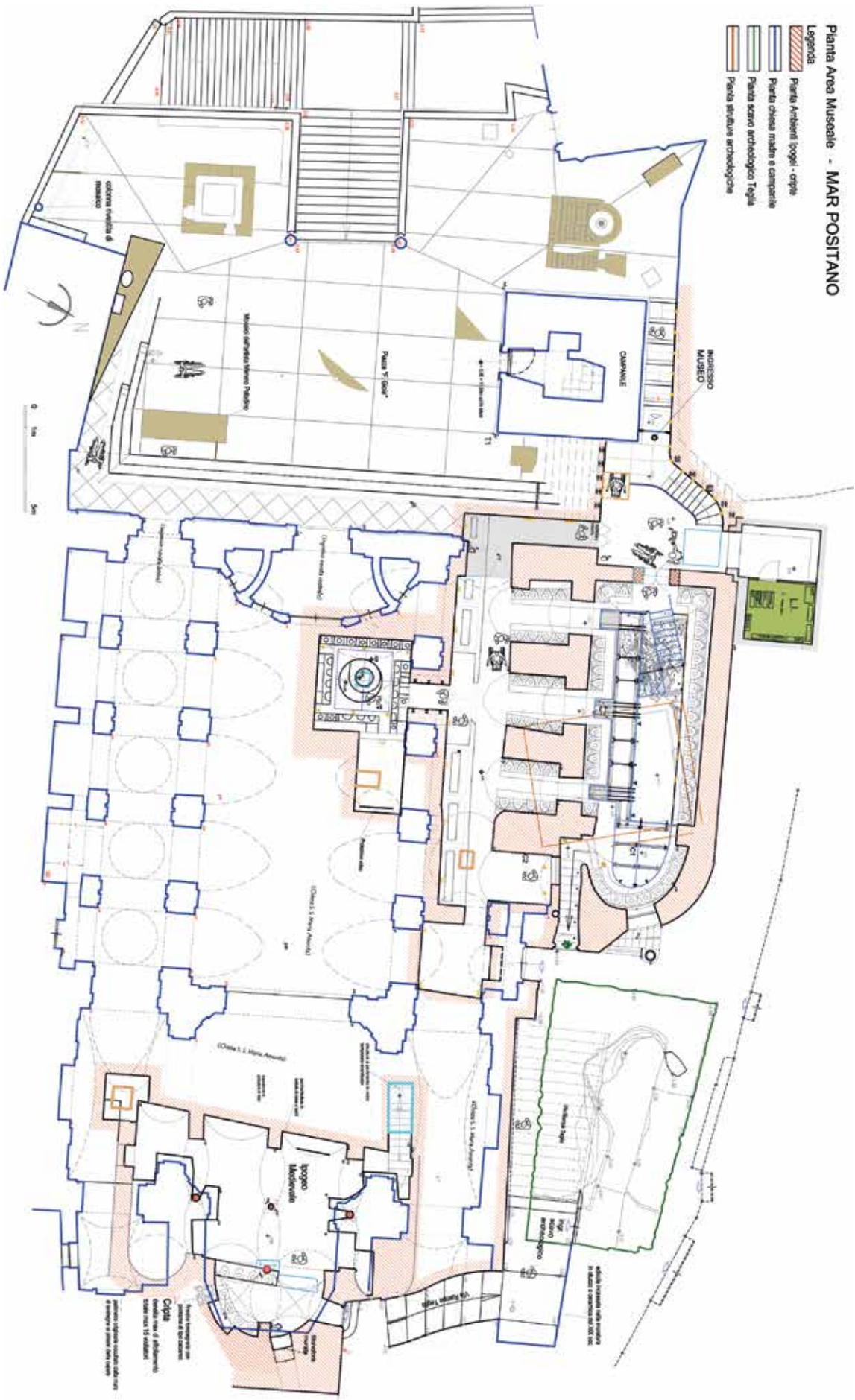


Fig. 3
Plano-altimetric survey of the current (2017) state of the hypogea equipped with the plano-altimetric projection of the above Santa Maria Assunta Church.

Fig. 4
AA east/west Section with a north view of the current state (2017) of the hypogea and the above religious rooms in the Main Church.

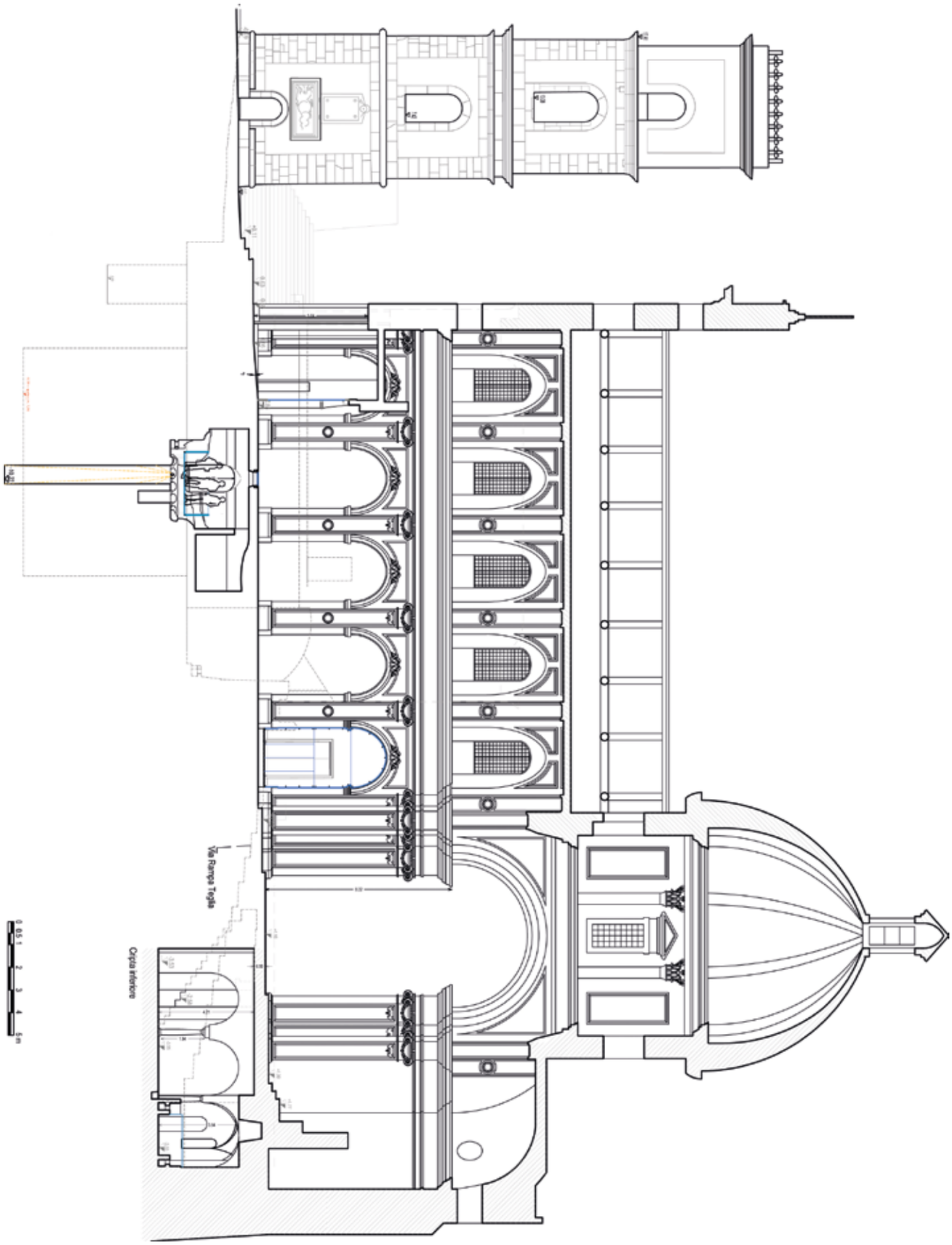
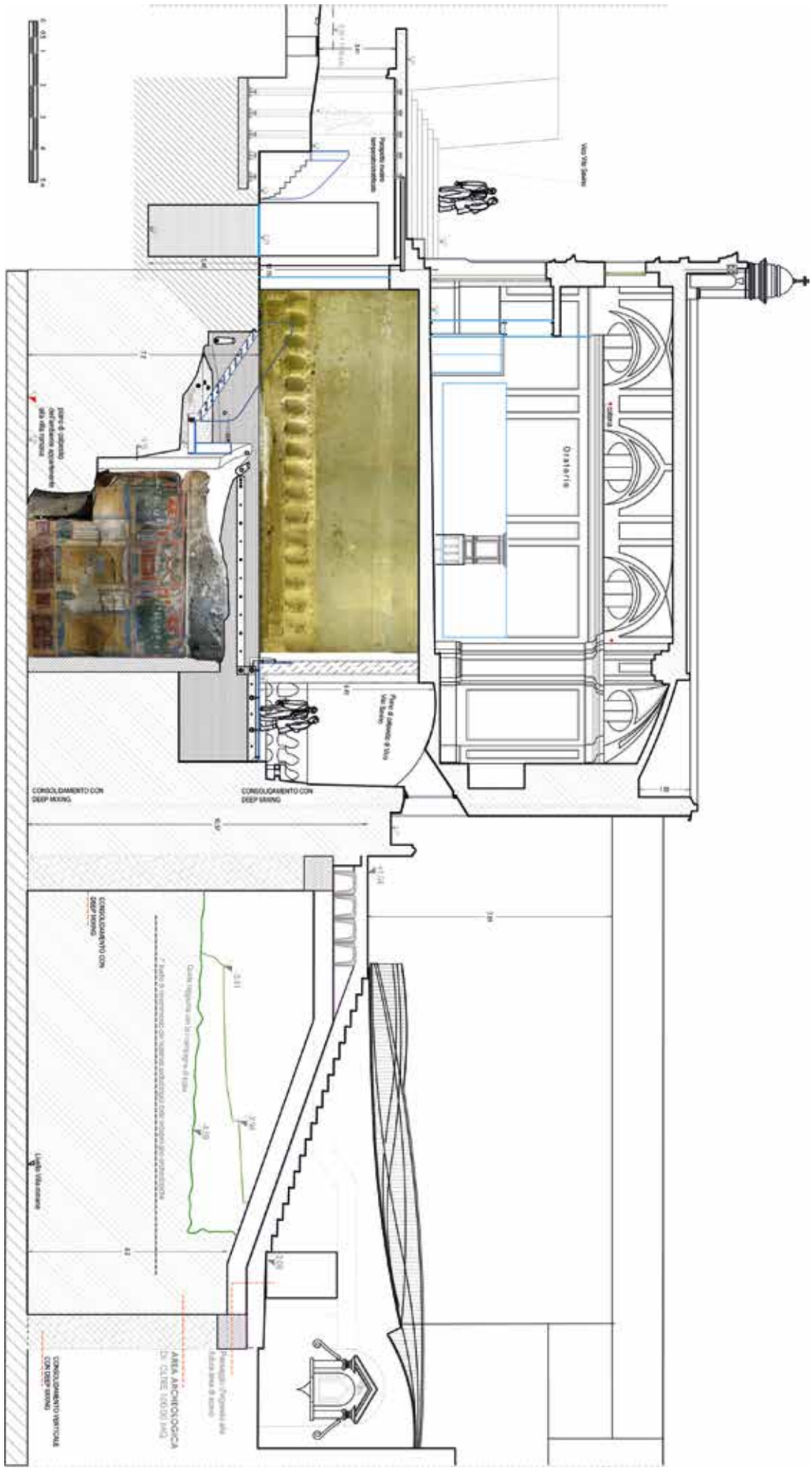


Fig. 5
BB north/south Section with a west view of the current state (2017) of the hypogea and the above religious rooms in the Main Church.

Fig. 6
CC east/west Section with a north view of the current state (2017) of the hypogea and the above religious rooms in the Main Church.



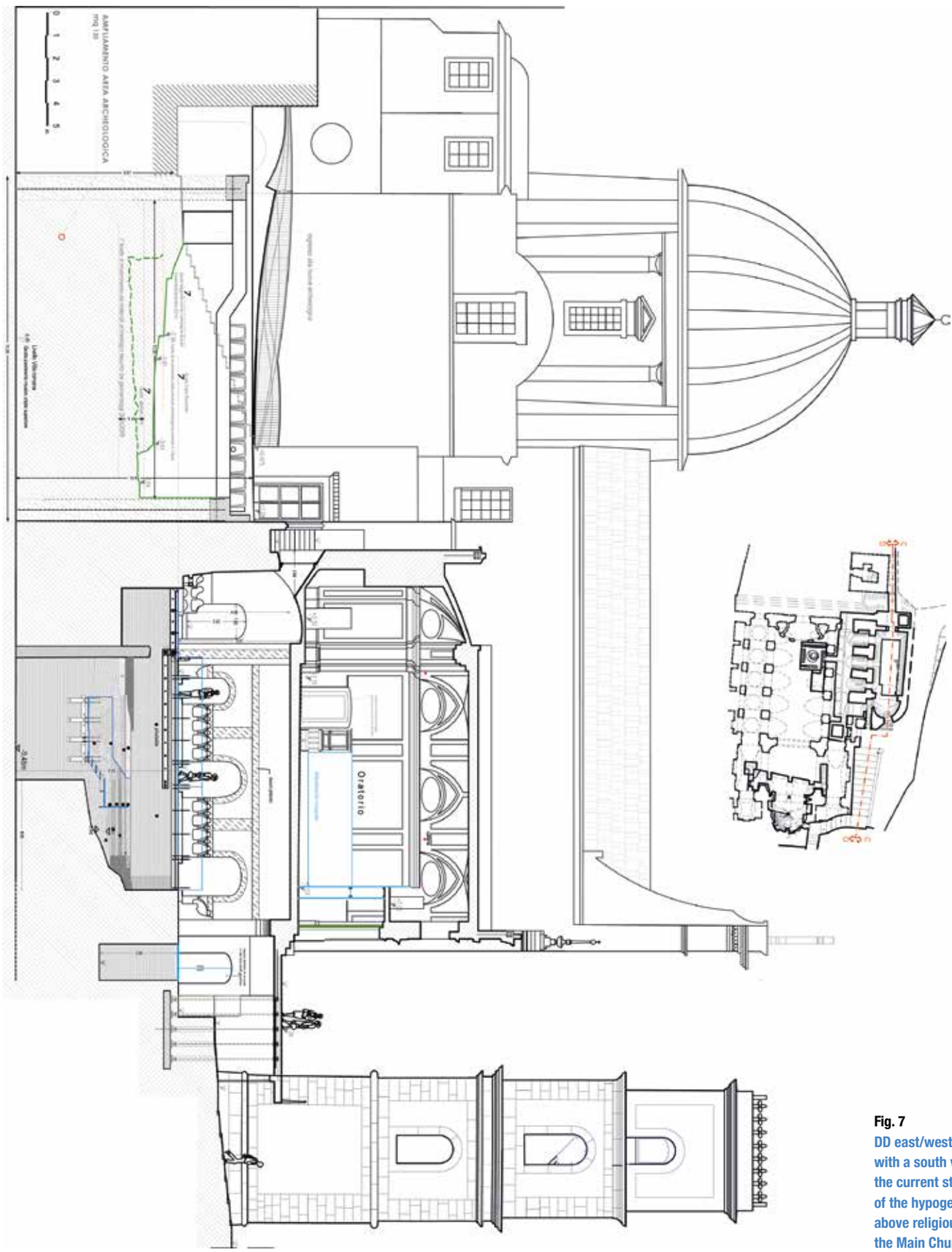
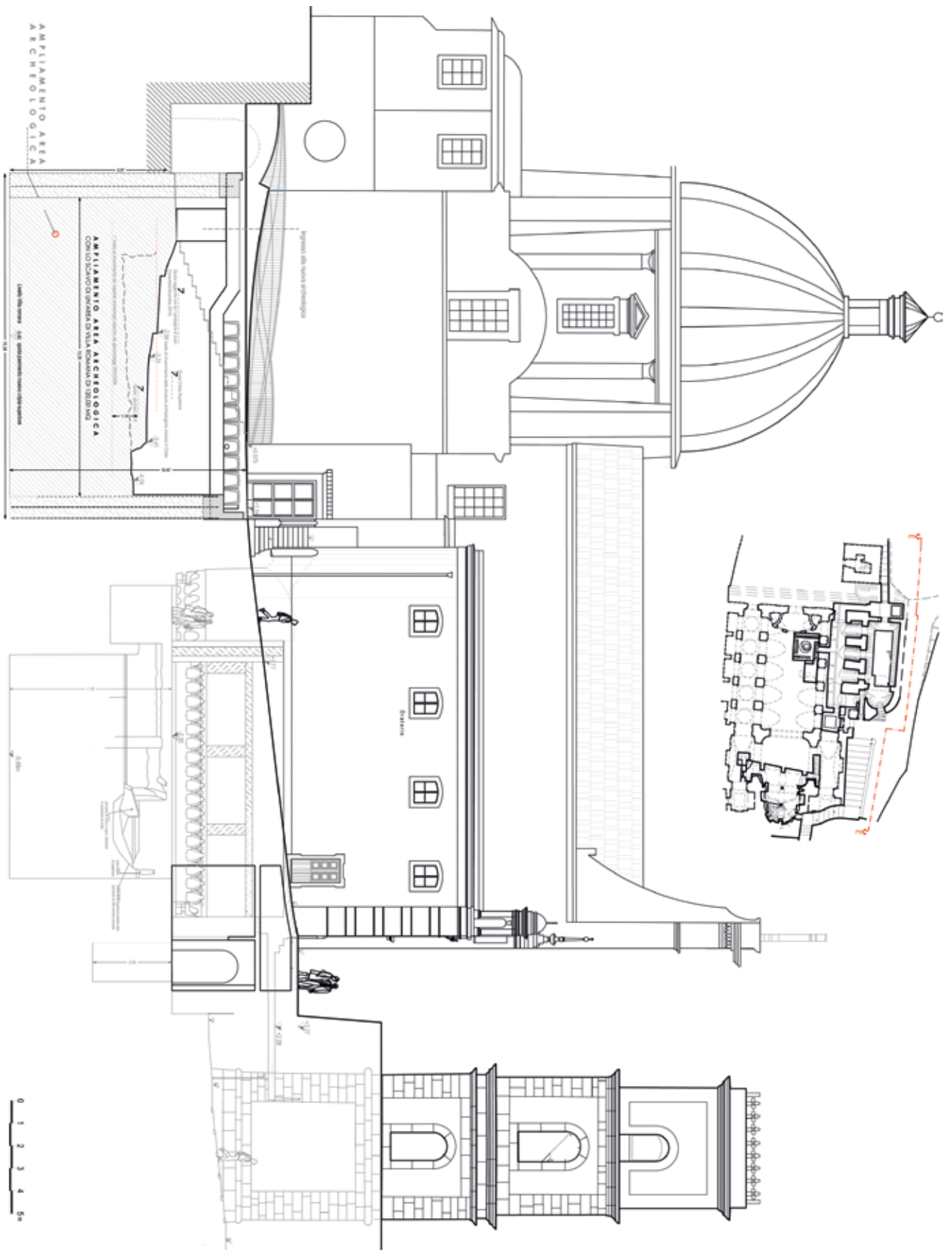


Fig. 7
DD east/west Section with a south view of the current state (2017) of the hypogea and the above religious rooms in the Main Church.

Fig. 8
EE east/west Section with a south view of the current state (2017) of the hypogea and the above religious rooms in the Main Church.



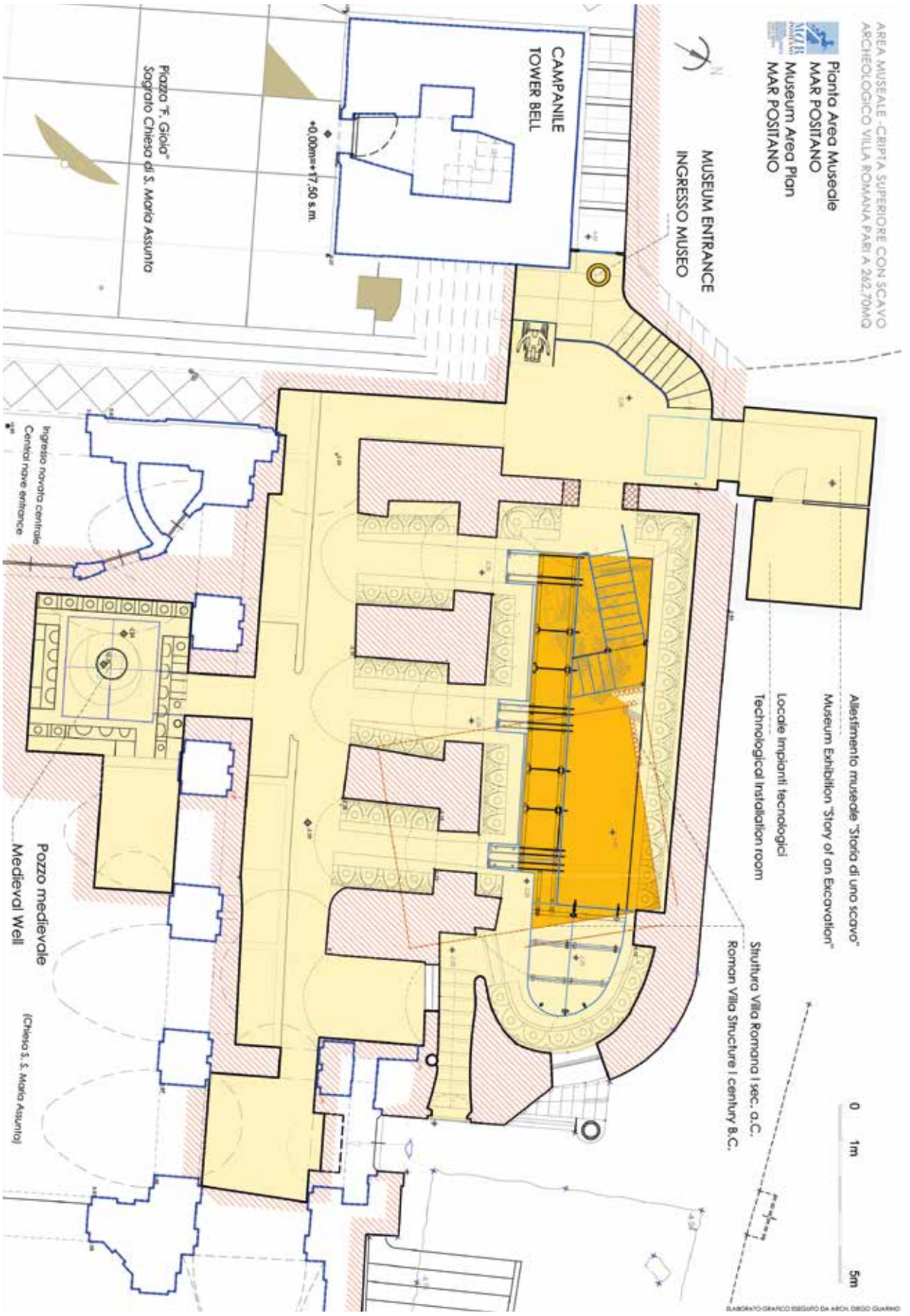
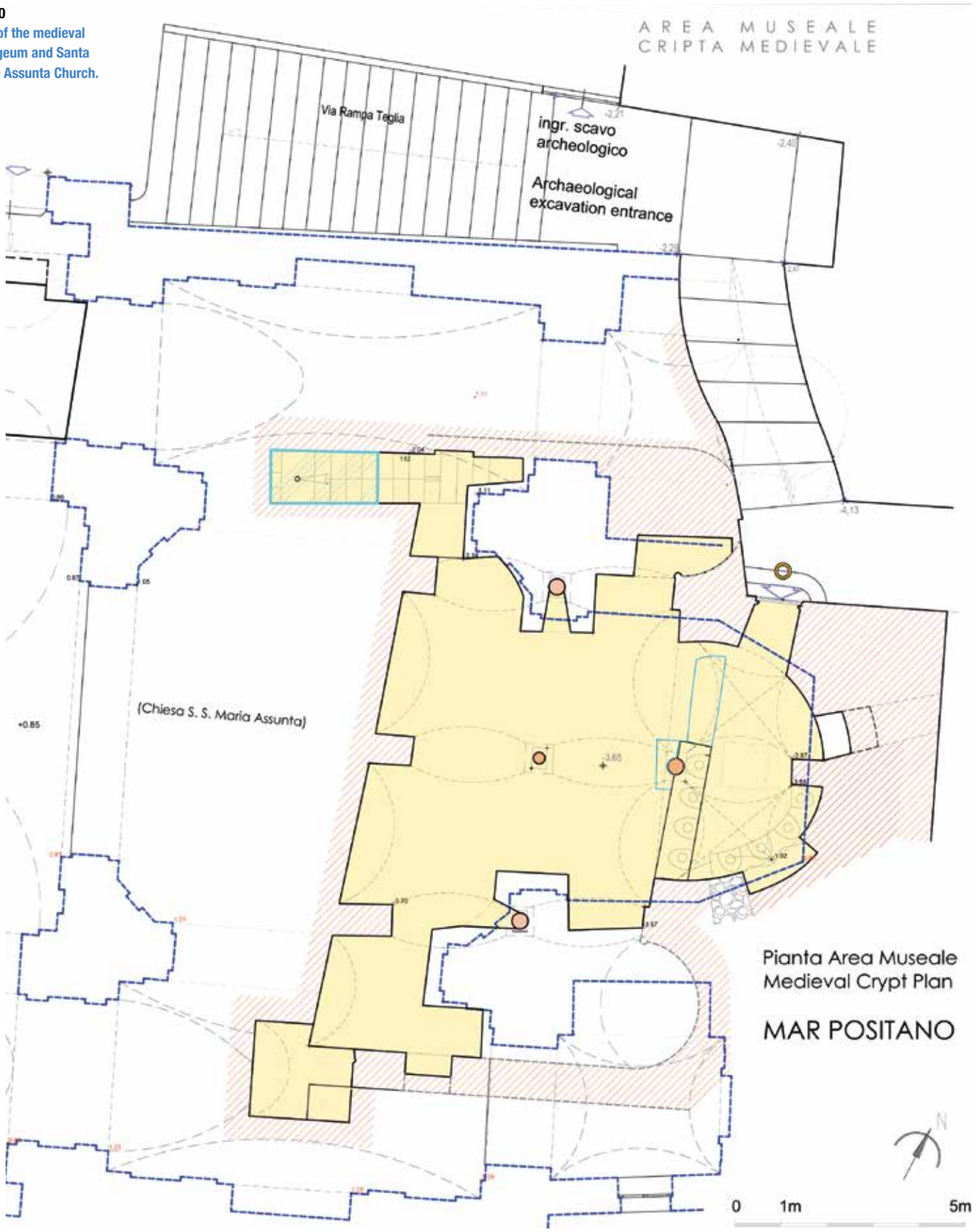


Fig. 9
Plan of the hypogeum and the archaelogical area of the 1st cent BC Roman villa

Fig. 10
Plan of the medieval hypogeum and Santa Maria Assunta Church.



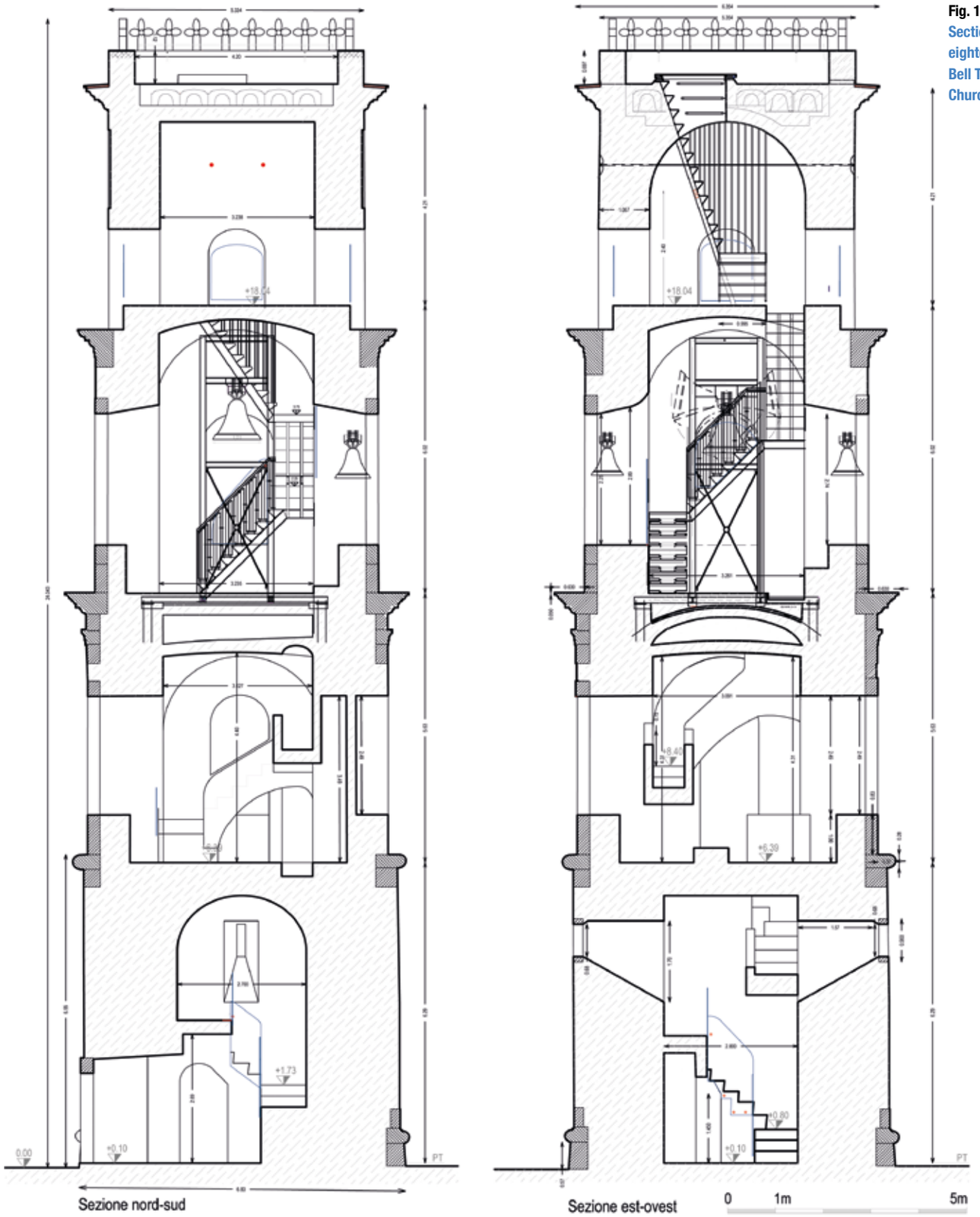


Fig. 11
Sections of the eighteenth-century Bell Tower of the Main Church

Fig. 12
West front of the eighteenth-century Bell Tower of the Main Church.

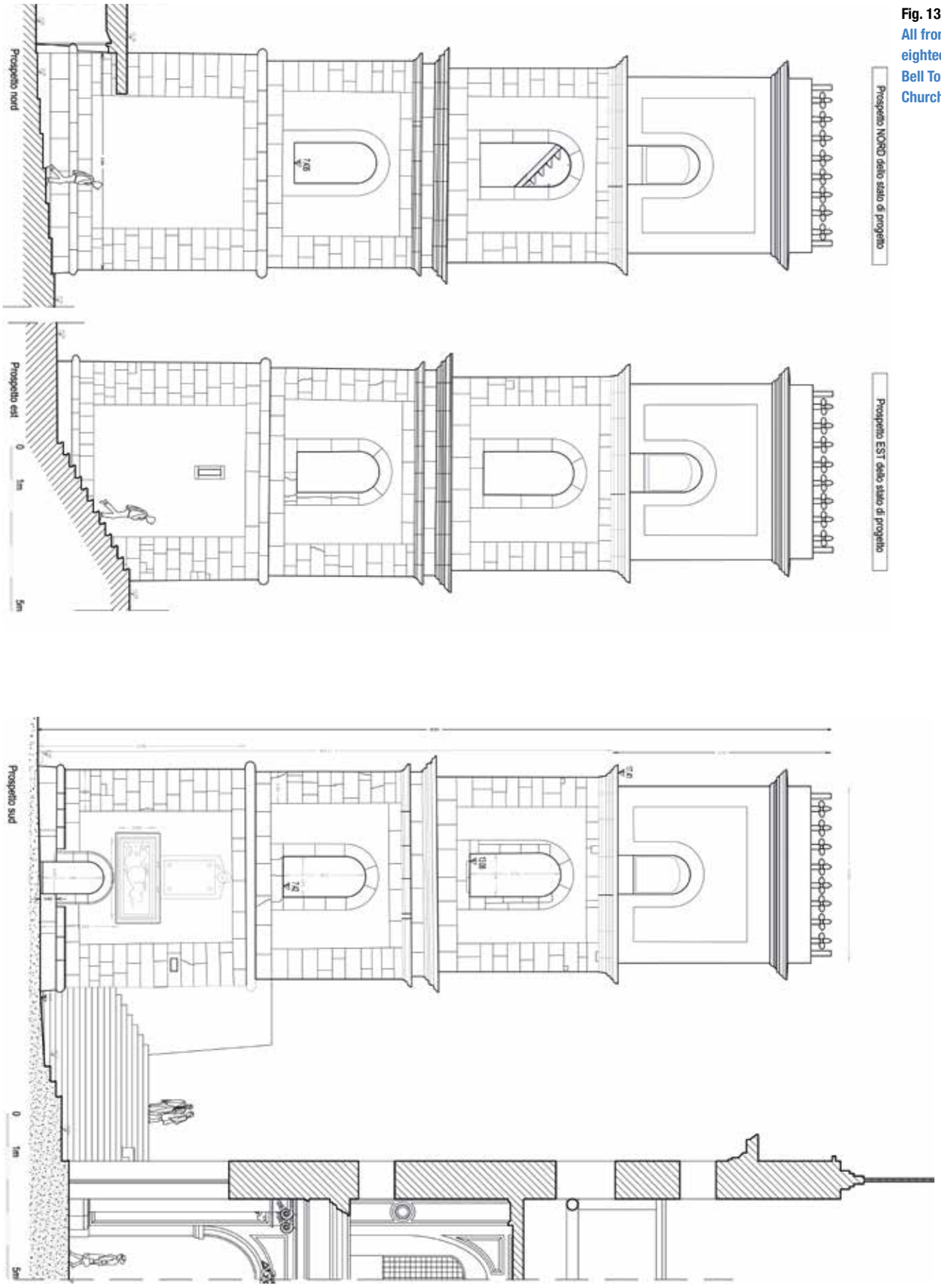


Fig. 13
All fronts of the eighteenth-century Bell Tower of the Main Church.