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**Interdisciplinary Knowledge for Conservation of
Ruins: Stratigraphic Investigations of San
Giovanni Battista Church (Sardinia, Italy)**

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**Interdisciplinary Knowledge for Conservation of Ruins:
Stratigraphic Investigations of San Giovanni Battista Church
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Abstract

The debate over how best to preserve and reuse ruins continues apace among academics around the world, remaining a still unresolved issue. In modern ages, different approaches have defined several solutions for rehabilitating these complex architectures. However, these do not appropriately consider their role of chrono-typological and material benchmark for the whole understanding of the fabric and consequent basis for their future sustainable enhancement. In particular, this is even more discussed in Sardinia where the high presence of ruined structures as well as the lack of documentary sources and funding has led mostly towards non-intervention policies. For these reasons, the present research contributes to this debate proposing an interdisciplinary methodology of knowledge specifically designed for buildings in a state of ruin. It involves different scientific areas: 3D survey with laser scanning technologies, archaeological graphic restitutions, stratigraphic surveys and classification of masonries types and diagnostic laboratory tests on materials (mortars, plasters, stones). The study highlights the valuable archaeological and documentary relevance of ruins for the understanding of their history, building technologies, materials and a state of conservation. It contributes to the definition of a design project, and to the identification of the typological and dimensional features referred to a specific context, also useful tool for dating coeval minor architectures, difficult to date. The investigation plan is here tested on the rural church of Saint Giovanni Battista (Bortigali, Sardinia, Italy), dating back to the XIII-XIV century and actually in a state of ruin. The case study is particularly representative of the complexity related to the investigation of Sardinian rural churches characterized by the lack of archival sources and an interesting variety of masonries types due to their different chronologies, even if it makes the buildings themselves the only available document for the comprehension of their constructive phases. The illustrated knowledge plan also provides a substantial contribution for the definition of possible actions for the conservation, re-functionalization and valorisation of these ruins.

Keywords: Archaeometry, Building techniques, Ruins, Rural churches.

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Introduction

The present study is part of a wider research focused on the chrono-typological definition of Sardinian masonry structures, based on archaeometric surveys. In fact, in the local context, studies on traditional masonry construction techniques are somewhat insufficient¹, particularly those aimed at dating historical architectures. Ruined structures are in this sense, useful case studies due to the easy accessibility of their anatomy.

Moreover, among the widespread palimpsest, rural churches seem to be even more interesting because of their capillary presence in the region and for their high degree of historical stratifications. A large percentage of ruined churches comes from the demise of medieval rural villages where they were the mostly central and important element of the settlement²; others are the remaining witnesses of processional rituals and itineraries used in the Spanish age (XVI – XVIII centuries), further are simply the direct consequence of modern disuse and oldness.

Although during the XX century, many of these religious buildings have been restored or even rebuilt, the majority of them still lay in a state of ruination³. Because of that, condition materials and techniques can be considered authentic benchmarks not only of the religious architectures, but also of the whole Sardinian historical heritage. Stones, mortars and plasters, fixed in their original building-time, can be assumed as precious stratigraphic witnesses. Craftsmen related to the construction of churches were also historically involved in other contemporary worksites such as in defense and civil buildings, so that it is common to find similarities in different kinds of assets. For this reason, these studies on rural churches could have a high impact in the understanding of other different building types.

The current paper shows the most significant case study investigated within the scientific research called *Ecclesiae Fabbrica*, carried out under an agreement between the Nuoro province and the Department of Civil-Environmental Engineering and Architecture (DICAAR) of the University of Cagliari⁴. With the systematic survey on Sardinian ruins both rural and urban⁵,

¹ Giannattasio, C. 2008. Lo stato dell'arte sullo studio delle tecniche costruttive in Sardegna. *Lo studio delle tecniche costruttive storiche: stato dell'arte e prospettive di ricerca* in Pracchi, (The state of the art on the Sardinian building techniques. The study of historical building techniques: state of the art and future researches) V. (ed.) Nodo: Como, pp. 53-57.

² Concerning abandoned villages: Milanese, M. (ed.) 2006. *Vita e morte dei villaggi abbandonati tra Medioevo ed Età Moderna (Life and death of abandoned villages between Middle and Modern Age)* (Atti del convegno, Sassari-Sorso, 28-29 maggio 2001). All'insegna del giglio: Borgo S. Lorenzo. (Life and death of abandoned villages between Middle and Modern Age)

³ Billeci B., Gizzi S., Scudino D. (eds.) 2006. Il rudere tra conservazione e reintegrazione, Atti del convegno internazionale di Sassari 26-27 settembre 2003, Roma, Gangemi.

⁴ This project has been financed by the Sardinian region and involved numerous researchers of the Department above-mentioned as architectures, engineers, geologists and topographers *Ecclesie Fabbrica*, project in collaboration with the Province of Nuoro and the Department of Civil, Environmental Engineering and Architecture – University of Cagliari. Scientific leaders: D. R. Fiorino and G. Concu (2014). The research is Published In FIORINO, CONCU (2014), *Il*

it also joins the academic research started ten years ago by of the Restoration team in the School of Architecture of Cagliari, carried out within the already quoted systematic survey on Sardinian ruins,

In detail, the case of the S. Giovanni Battista church in Bortigali, analysed through its stratigraphies, provides some main key information in the Sardinian history of construction. At the same time, it summarises the main questions and issues related to the study and dating of the Sardinian traditional minor architectures, on the other hand, it is representative of the experimentation of a scientific and interdisciplinary research plan specifically designed for buildings in a state of ruins here specified and adapted to the local settings. Furthermore, this is considered relevant, in order to recognize and highlight their archaeological and documentary significance, as well as to study the possibility of conservation, re-use and valorisation.

The Methodology

Architectures in state of ruins, according to their state of conservation, offer a great opportunity to study the monument directly from its own structures. In fact, they can be considered as “*valuable chronologically benchmark*”⁶ for the possibility to study their historical materials, traditional building techniques, architectural typologies as well as their structural state of conservation.

This multidisciplinary study, based on indirect and direct studies, has involved a different field of knowledge with a series of documentary, technical and archaeometric studies. In detail, the activities carried out were:

1. preliminary archival research;
2. 3D surveys of the monument;
3. analysis of the walls by characterizing the building materials and the state of decay;
4. dimensional analysis of the constitutive elements and the related working techniques;
5. analysis of the units and stratigraphic relationships in order to define relative chronologies;
6. documentary comparisons between the

progetto Accessit: L'accessibilità ai ruderi degli edifici di culto della Sardegna. La Metodologia "Ecclesiae Fabrica". In the project, the geometrical surveys are been coordinated by G.Vacca (DICAAR); the material surveys are been coordinated by S.M. Grillo and carry out in the laboratories DICAAR and LabMast. The archaeometric study here presented was carried out by a the strict collaboration of a multidisciplinary team (scientific coordinator D.R. Fiorino; 3D surveys G. Vacca; archaeological and stratigraphic survey D.R. Fiorino & E. Pilia; scientific coordinator for sampling and analysis of materials G. Grillo LabMast - Mediterranean laboratory for historic and traditional materials), collaboration for graphic representation, sampling and thematic analysis E. Pilia).

⁵ This research is focuses on dating the Sardinian masonries (XII-XIX century), with particular attention to the study of Sardinian rural churches and defence heritage.

⁶ Pilia, E. & Pirisino, M.S. 2016. “Gaining knowledge of materials and chronologies of the ruins for the preservation of historical centers: the case study of Monteleone Rocca Doria in Sardinia (Italy)”, in Amoêda, R., Lira, S., Pinheiro, C. (eds), *HERITAGE 2016 – Proceedings of the 5th International Conference on Heritage and Sustainable Development*, Green Lines Institute, p. 1404.

sources and the monument for the absolute dating of the different wall sections;
6. assessment of the state of conservation.

The investigation is tested on S. Giovanni Battista church, never studied before. This case study is particularly representative of the complexity related to the investigation of Sardinian rural churches characterized by the lack of archival sources and an interesting variety of masonries types due to their different chronologies. Therefore, the study has permitted to achieve the essential knowledge for the comprehension of the relative chrono-history of the fabric, useful for the future identification of sustainable intervention criteria.

S. Giovanni Battista Church

The rural church of S. Giovanni Battista (Figure 1) is located in the countryside of Bortigali, a small village in the northeast of Sardinia near Macomer, at the foot of the Santu-Pedre Mountain. In the medieval period, the town was included in the ancient Marghine department also called Feud of the Maghine's Contrada or Incontrada, inner the Logudorese Giudicato⁷, and it would have had a great importance for its position being cited by numerous travel writers.

As the literary sources⁸ remind, it had only 540 buildings, around 3000 habitants with irregulars and dirties streets; its economy as nowadays, was only typify by agriculture and pastoralism.

Figure 1. *Church of S. Giovanni Battista. Localisation*



The church was a rural sanctuary, oriented on the West, surrounded by a perimeter wall incorporating a gate of similar construction. It is composed by a main rectangular body with two naves divided by a septum of stone arches

⁷ Barbarossa, Cabu and Iossu, (2004) *La Sardegna paese per paese* (Sardinia town by town) in ANGIUS V., CASALIS G., *Il dizionario Angius/Casalis 2*, Cagliari, p.166

⁸ Barbarossa, Cabu and Iossu, (2004) p. 166-167; Valery (1996), *Viaggio in Sardegna* (The Sardinian journey) Ilisso Editor, Nuoro, pp 69-70

with an external vestibule on the south, which provided shelter for pilgrims during festivities and in particular during summer *novene*, or periods of nocturnal prayer. The presence of these two naves is an occasional event in this building, not liturgical or religious, but caused by a later addition. In fact, this kind of church shows morphological and formal characters well codified⁹ in Sardinia. The remains of the roof, nowadays collapsed, permit to suppose that it was composed of wooden trusses placed above engraved corbels. Directly above there was a wainscot covered in traditional Sardinian roof tiles. A number of decorative and structural elements can be found around the site which clearly originate from the collapse of the church walls, many of which are arranged haphazardly where they fell and are in part buried. Unfortunately, it has not been possible to carry out a preliminary archaeological investigation or an excavation of the area in such a way as to reconstruct the original layout of the church.

Regarding the origins and the subsequent transformation of the church, the available historical documentation has proved to be poor and inadequate. It has therefore been necessary to undertake a detailed and specific archival investigation, in order to reconstruct the chronological history of the events that have shaped the church's architectural shape.

The sources of the Historical Diocesan Archive of Alghero report that the building dates back to the seventeenth century (near 1650), but, as the studies confirm it must be more previous, around the XIII-XIV centuries as other Sardinian rural churches with similar characteristics.

In particular, the first document to mention the church recounts a pastoral visit done by Monsignor Diaz de Aux in 1684, detailing the administrative costs of the “*iglesia de San Juan Baptista*” and the “*hazienda de San Martin*” nearby. It reports: “*Mas el libro de los assientos de entrada y salida de la Iglesia de San Juan Baptista cui obrero es Juan Baptista Carta Suzarello y en las quantasque de su administracion ha dado la alcanza de la Iglesia en 78.?? 8 dineros = Mas ...*”.

Further memories in which the church is mentioned are other two pastoral visits. The first one, in 1774, done by Mons. Radicati, reports the state of the damage of the building in these years: “*Rurales ecclesias S. Johannis omnibus ad sacrificios missa necessarius destrutta et cuius tecti pars ruyiti indicto inposuit*”. The second one, in the 1833, done by Mons. Arduino, cites its existence: “*... chiese rurali di San Martino e San Giovanni, ove fatta visita nelle medesime rimonto a cavallo...*”.

Finally, an important letter dating to 1912 and written by a Reverendo Piu, priest of Bortigali at the turn of the twentieth century, states that the church was closed for religious celebrations in 1870 and re-opened only in 1905: “*... festa di S. Giovanni nella Chiesa patronale, che dista mezz'ora circa dal paese.*”

⁹ Coroneo R. (1993) *Architettura romanica dalla metà del Mille al primo '300*, (Romanic architecture between the half of XI and first XIII century) Ilisso Editor; Coroneo R., Serra R. (2004) *Sardegna preromanica e romanica*, Jaka Book Editor; Serra M. (2013) *Guida alle chiese campestri della provincia di Nuoro* (Guide of rural churches in the Nuoro County).

Questa Chiesa trovandosi in uno stato rovinoso era chiusa al culto già da 40 anni, venne riaperta or 7 o 8 anni e ora la festa è divenuta popolare...”

It is clear that the archival investigation into the historical background of the church yielded poor results, with only a few documents relating to its construction and state of conservation.

Actually, the church is completely in a state of ruin (Figure 2). Its walls are in part collapsed in places and partially unstable, while the roof is completely collapsed. The vegetation infests the building and compromises its legibility even more than its stability, both outside and inside. Plasters and mortars are lacking and for the most part are detached and the structural collapses create an irregular floor, more instable in the south access.

Regarding the traditional building materials, they are characterized by rhyolites and basalts outcropping locally in the area, cemented by an earthen mortar and covered by various kinds of lime plaster and recently in concrete. They are suffering from the natural but fast process of damage that characterized every building in state of abandon.

Figure 2. Church of S. Giovanni Battista



Architectural Surveys and Stratigraphic Analyses

Considered the morphology of the structures and following the explained investigation process, the first step was the accurate architectural survey and representation of the monument. A geometric survey was carried out with laserscanning, GPS technologies¹⁰, based on a 3D model that trough point cloud and ortophotos permitted us to draw plan, vertical and horizontal sections in 1:50/1:20 scale. Based on of the ortophotos, archaeological restitutions were also made to represent precisely and in detail the nature of materials, the building techniques and the surface finishes. These drawings have been the graphical representation for the following surveys (Figure 6). Starting from the architectonic restitutions, the analysis of stratigraphies has been carried out¹¹

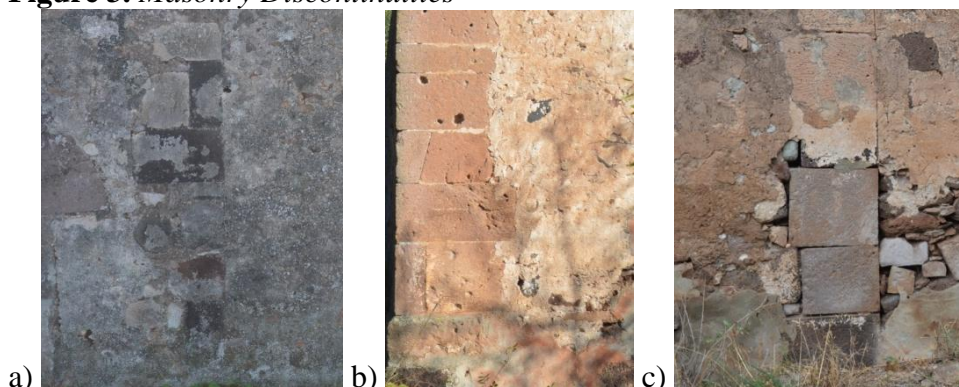
¹⁰ The geometrical surveys are been coordinated by G.Vacca (DICAAR – University of Cagliari) with the use of the Laser Scanner Faro Focus 3D.

¹¹ Fiorino D.R. 2009. La stratigrafia urbana (Urban stratigraphy), in Giannattasio C., Scarpellini P. (edited by), Proposte per Stampace. Idee per un piano di conservazione del

(Figure 5). Since the first definition of the stratigraphic units, this analysis has revealed a series of interesting discontinuities and interfaces that dividing similar typologies of masonries have made the chronological interpretation difficult to understand (Figure 3).

In details, the façade shows the presence of cantonal in rhyolite and basalt in correspondence to the central nave (Figure 4a). The same structure of cantonal can be found in the north side and in the south side made only by block of rhyolite (Figure 4b). On the East front, corresponding to the presbytery, there is another evident interruption between the two cantons that signs the central nave from the other two lateral additions (Figure 4c).

Figure 3. Masonry Discontinuities



This could mean that in the past the original body of the church was composed by the current middle nave, with a further later addition of the northern nave and after of the vestibule on the south.

The simultaneous accurate stratigraphic study of the masonries has permitted to understand in depth the peculiarities of all the structures and their relative chronologies. According with the stratigraphic analysis, stratigraphic units (US) for masonry (USM) and stratigraphic units for coverings (USR) have been recognised and analysed for their relationships (Figure 5).

In the main façade, it is clear that the USM1017, USM1018, USM1020, USM1023, characterised by cantonal in rhyolite and basalts are, with more probability, the oldest. In fact, they are covered by all of the others USR and reflect the width of the central nave. It could be represented the first phase of construction of the fabric (hypothetically XIII cent.) when the church was mono-nave. In a following phase it can be located all the other USM and USR identified, linked to the addition of a lateral nave on the north and of a vestibule on the south. The USM1019 is characterised by a cantonal in reused ashlar of rhyolite and basalts, while the cantonal USM021 was built with only rhyolite. Also, other interesting stratigraphies are the USM1024, a probably cut made to emphasise the access at the church; the USR1020 and the decorative

quartiere storico cagliaritano (Proposal for the Stampace quartier. Ideas for a conservation plan of the historical district), Roma, Gangemi, pp. 69-74.

elements USM1025, which were certainly applied to protect the new erected masonry. Finally, in modern times, a little flat belfry was added (USM1026).

The west façade and its stratigraphy confirm what can be read from the façade. With the exclusion of the plasters, which in part are different in composition (USR1027, 1032, 1037, 1047), it can be identified clearly that the USM1028 has the same characteristics of the previous USM1018. This USM1028 signs a deep discontinuity in correspondence of the main nave, supporting the hypothesis of the additions. Furthermore, USM1031 and USM1036 have the same characteristics of USM1019 and USM1021, respectively and are in 'contemporary relationship' with the near masonry in rubblework made by rhyolite and basalt. Considering the plasters, the USR can be related indirectly with the USR in the façade, while USR1047 seems to be different in the composition and stretch out above. The USR1037, 1033, 1045, 1049 are modern concrete plasters, with great probability added in recent times.

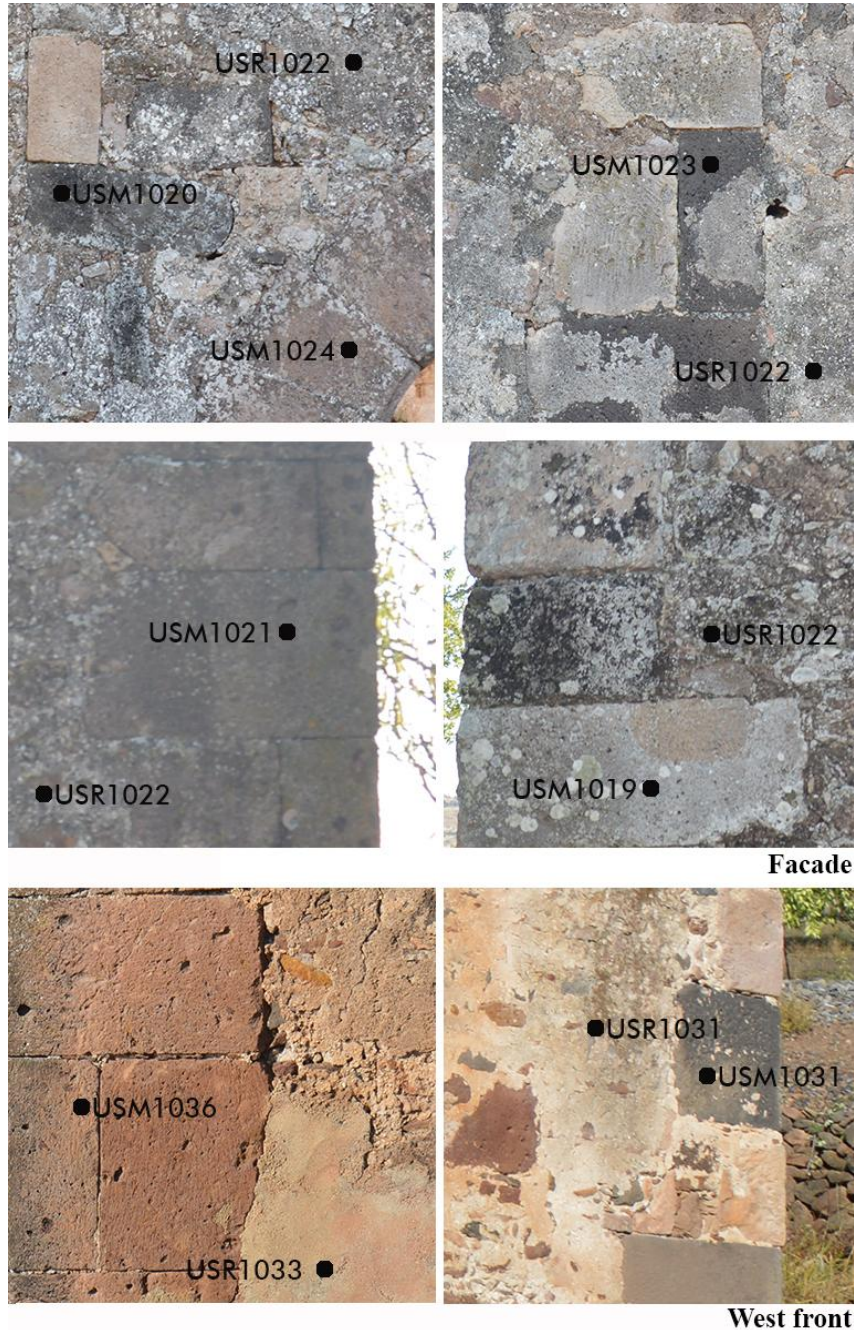
Analysing the north front and the south front, can be read and interpreted other important considerations about the history or the fabric. Firstly, from the north façade it can be recognised a new kind of masonry USM1003 (Figure 7b, external). Considering the dimensions of the ashlar and the thickness of the masonries, this unit could be made from the reuse of materials from the previous front and linked with the cantons, built with reused materials too. Moreover, this kind of masonry is punctuated covered by lime plasters from different restorations (in Figure 5 USR1011 and USR1016; in Figure 6: S02: BI11 and BM10 respectively). Finally, on the south façade, the evolution of the building for the addition of the vestibule is clearly readable. This new space, in large scale diffused in the entire island, has caused the opening of a second access, cutting the original masonry of the main body. A rubblework of medium-small size (Figure 7c, internal) closes the vestibule and it is linked to two cantons USM1021 and USM1036, having the same typology already seen for the façade.

The Analysis of the Materials

Following the stratigraphic analyses of masonries, a further investigation of stratigraphies has been carried out on the different types of building materials: lithotypes, mortar and plaster used on the walls of the ruin, each one being then assigned to a particular historical stage of construction. This analysis complements the historical documentation by contributing further technical information to broaden the understanding of the original materials and their chronology. To provide an analytic description of the construction materials and to understand their state of conservation, we performed a reasoned sampling organised in stratigraphies of the natural and artificial stonework. Specifically, the samples were analysed according to the following protocol: selection of the reasoned sample; their study by means of transmitted

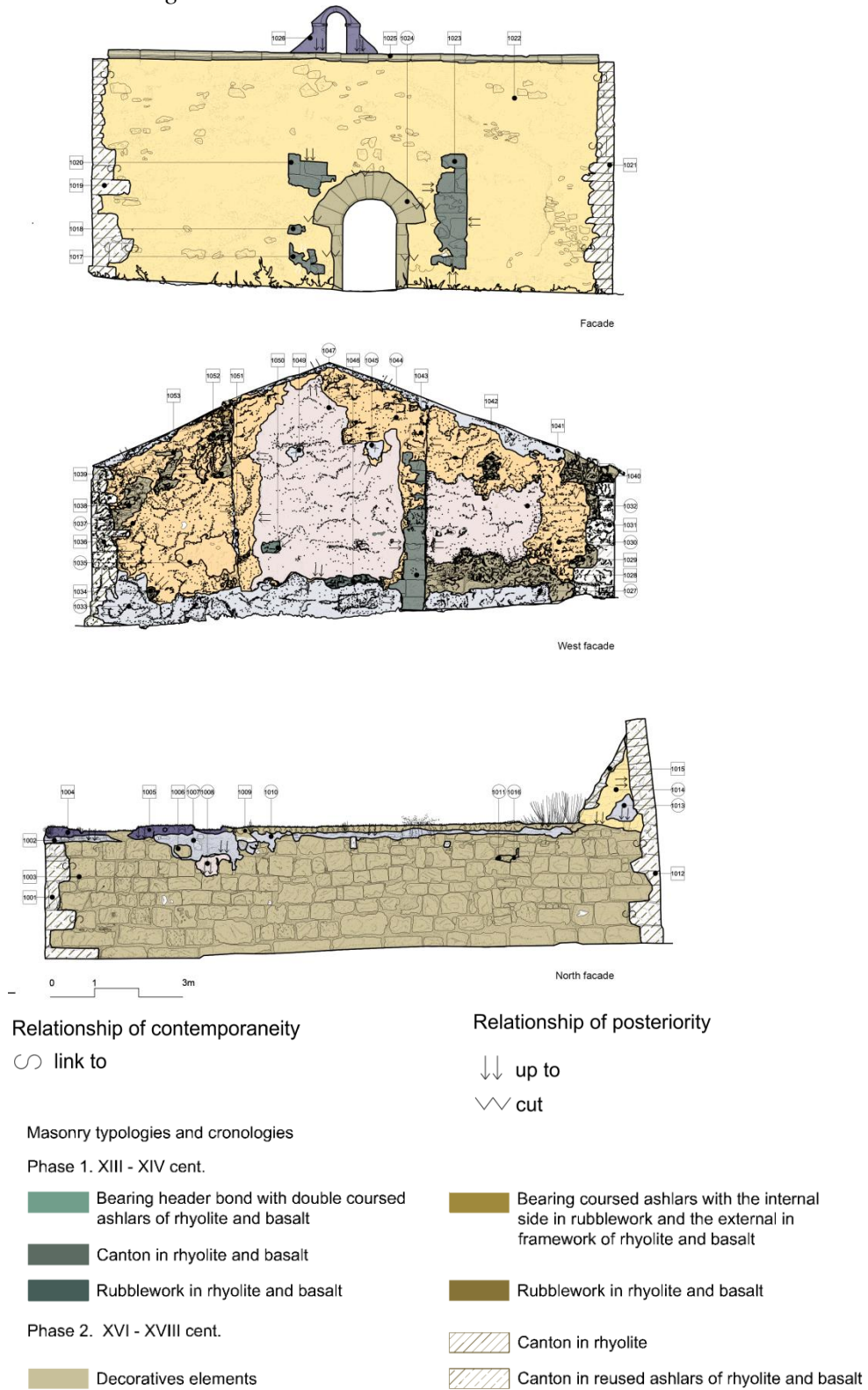
and reflected light microscopy; study of the aggregate and of the binder separately by means of x-ray diffractometer¹².

Figure 4. *Individuation of Some Significant USM and USR from the Façade and West Front*



¹² The material surveys have been coordinated by S.M. Grillo and carry out in the laboratories DICAAR and LabMast with optical microscope in transmitted light Zeiss Atioplan and diffractometer Rigaku Ultima IV, in parallel optic, radiation $\text{CuK}\alpha$ a 30mA; pattern 5° - 65° .

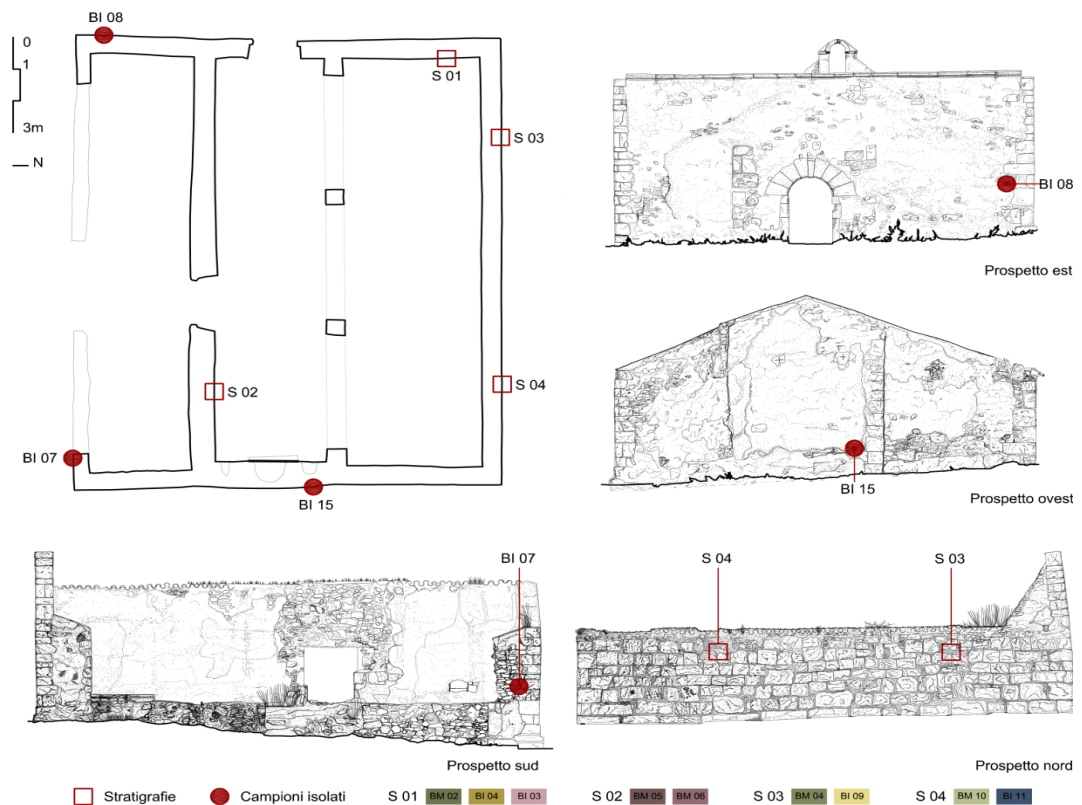
Figure 5. *Stratigraphic Analysis with Individuation of Masonry Techniques and Chronologies*



The analyses show that all the mortars were made of soil (BM02), as it is clearly visible in the internal north façade (Figure 6b: S01), while a little percentage of lime was added in the mortars realised in the hypothetical phase of reconfiguration (BM10). All the masonries were made of local lithotypes: rhyolites and basalts, different in shape and dimension. As can be seen from the masonry samplings, all the internal masonries were made in rubblework with a prevalence of rhyolites (Figure 6a, b, c), softer than basalt in the phase of cutting. The same typology can be found outside (6c) where the presence of concrete and lime plasters with modern mixture confirms the later addition of the vestibule on the south. Instead, a middle phase of construction could be represented by the masonry technique on the external north façade made (Figure 6b) where squared blocks of rhyolite and basalt define a regular weave.

Overall, these construction techniques were used in different periods in different sections of the building. As a consequence, it is difficult to ascribe with certainty a single construction technique to a phase, as the techniques were used indifferently. For that, the same masonry could appear in more than one stratigraphic phase, and the only way to recognize the chronological sequence is to identify the discontinuities in terms both of mutual relationships between structures and changes in the mortar composition.

Figure 6. Plan of Samplings, and Images of the Thin Sections under the Optical Microscope in Transmitted Light and X-Ray Diffraction Analysis



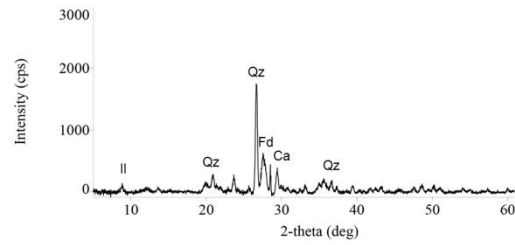
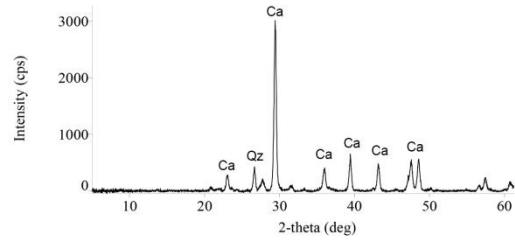
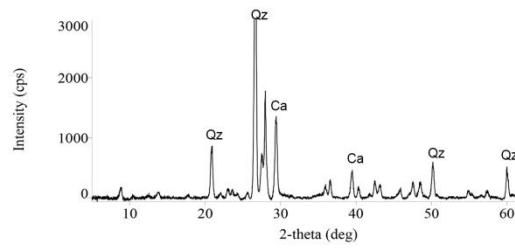
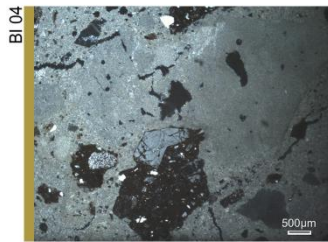
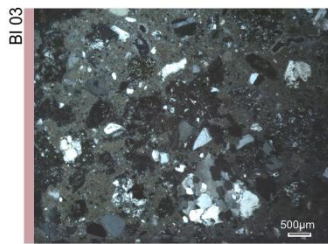


S01



S02

S01)



S03)

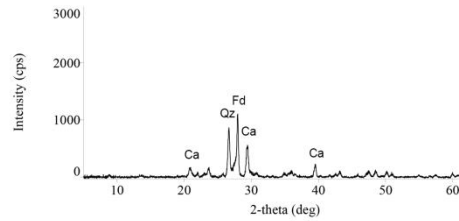
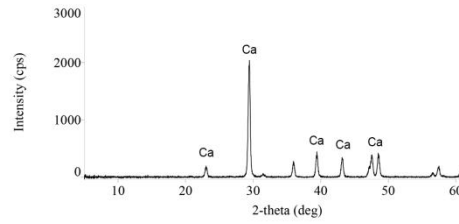
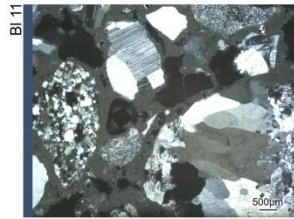
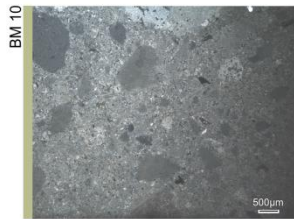
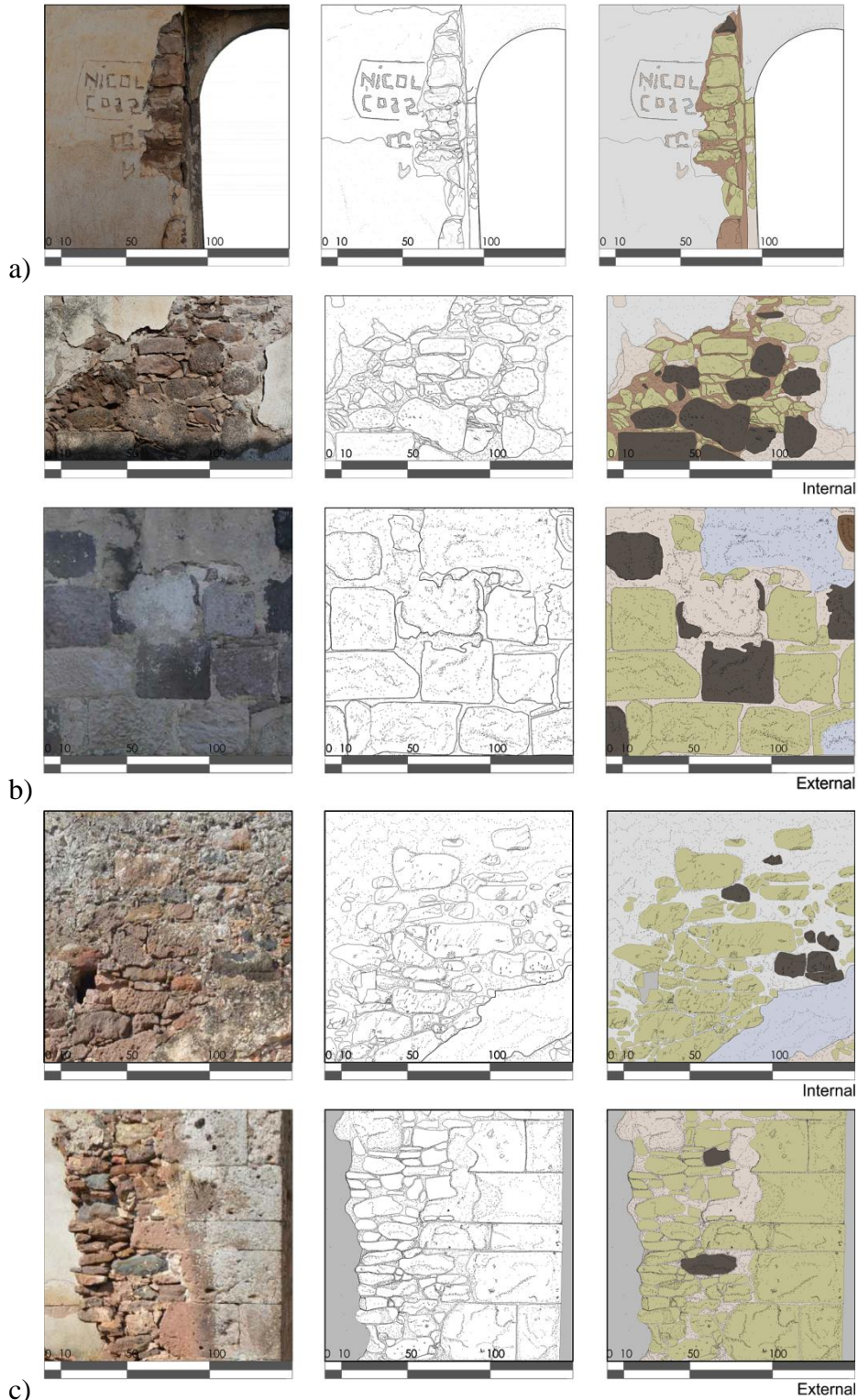









Figure 7. Masonry Samplings



Materials

 Basalt	 Wood	 Lime mortar
 Rhyolit	 Soil mortar	 Concrete plaster
		 Lime plaster

Conclusions

In conclusion, from the study of the archival documentation, the analysis of stratigraphies and materials, the comparative study of building typologies also with other coeval rural structures, the present study has permitted to reconstruct the relative chronology of the church. The originally structure was constituted by a unique nave covered with a wooden roof. As resulted by the minero-petrographic analyses, earth mortars and lime plasters characterised all the masonries, even if in different composition. Then, the church was built up with a new re-configuration. The northern front was demolished and re-erected as an arcade with a pillar and arches from the same materials with the other masonries; a new nave was added on the north. Furthermore, a vestibule was built in the southern front for rural celebrations, as showed by the discontinuities. A final phase is related to the works post 1774, when the sources reported the collapse of the roof, certainly reconstructed because of the documented reuse of the structures until of the XX century. New concrete plasters were sporadically used to restore the masonries.

To conclude, this interdisciplinary research confirms also the necessity to perform an accurate archaeological excavation of the site capable of individuating and cataloguing the fallen masonry, for revealing other elements of the original configuration of this building. It is so clear that only through an appropriate interdisciplinary approach it is possible to understand the complex nature of a ruin, including its material, building techniques and stratigraphy due to the definition of Chrono-typologies and as a consequence, the right degree of intervention.

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