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Cognitive methodology and diagnostic plan for cultural heritage conservation.

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Abstract

The article proposes the results of a research aimed at supporting a conservation work and enhancement of a monumental cult building of the Byzantine era, the abbey of Santa Maria del Pàtire, located in the municipality of Rossano (CS - Italy) one of the most interesting Byzantine architectures in Calabria. The research started with a historical survey and an identification of the relevant components of the abbey. The heart of the research is the characterization of the church constitutive materials for conservative purposes, in a cultural perspective of prevention of potential degradation forms.
To this end, a diagnostic plan was developed, articulated in coordinated phases that include both the cognitive analysis of the environmental context and the cognitive analysis of the artefact through a specific anamnesis and a photographic dossier. The meaning of the methodological approach in the preventive analyses is therefore emphasized that carefully and specific techniques must be used and may be useful for guiding the most suitable technical inputs or suggesting solutions for effective conservative action.

I. INTRODUCTION

The Santa Maria del Patire abbey in Rossano (CS) was founded by Bartolomeo di Simeri in the 11th century; it is one of the most important monasteries in Calabria, that between the 12th and 14th century was not only a place of prayer but also one of the most thriving cultural and artistic center, thanks to the presence of a scriptorium, which operated until 1587. Even today, the sacred building represents well the splendor of the religious and artistic beauty of the majestic Byzantine Rossano. In order to study the state of the constituent materials conservation of the Santa Maria del Patire Church, it has been performed a complete diagnostic plan.
The diagnostic plan has been articulated in different phases, which start from the cognitive analysis of the environmental context, taking into consideration many factors such as soil, climate, structural characteristics and settlement work; and a state of the art about historical and artistic information, acquired even through historic and photographic surveys.
After the monument contextualization, the attention has been addressed to a specific anamnesis, to finally carry out results from the diagnostic approach aimed to relate the materials characteristics in relation to their state of preservation. After an initial macroscopic description of the materials, the investigation has been focused on some representative samples by petrographic analysis by optical microscopy. The proposed methodological approach, based on preventive analyses, is very important in order to select the most suitable technical inputs or to adopt the best solutions for effective conservative actions.
In this paper this approach is illustrated through a singular case study, the monumental byzantine church of Santa Maria del Patire

II. METHODOLOGICAL APPROACH

The use of advanced knowledge, represented by synergistically coordinated competences aimed at achieving a common goal, may help the development of cognitive paths capable to guarantee the heritage protection, conservation and enhancement [1].
The basis on which is founded the architectural monument study includes a multidisciplinary pathway necessary to reconstruct all aspects for a possible approach to historical, artistic and architectural artifact. The process of restoration provides an important preliminary step, very complex and articulate, aimed to collect useful information in order to make design decisions more effective and relevant to the specific case [2,3]. Therefore, there is a clear need for defining methodological procedures enable to acquire and outline the knowledge framework of a monument; this is a necessary condition to identify its conservation state and to detect the most suitable actions to take based on systematically collected information [4,5].
The proposed procedure, meant as an integrated innovative approach to diagnostic, becomes an opportunity to create appropriate synergies to achieve coordinated convergence in the correct and complete management of the information about a historical and architectural artefact comings from different expertise areas.

2.1. The geographical context

The Monastery Patirion, also called Pàtire from the greek word "Pater", is located 605 meters on the ridge of the Sila flat plateau (fig.1).
On the crest of a spur on short coastal strip between Rossano and Corigliano ciies, between the valley of the Cino in the north and the south of the Aranci valley, it is dominated in a radius of 3-4 km from a circle of wooded ridges, with the Serra Castagna peak at the center (1300m) which protect the esplanade by the winds and harsh winters.

Fig. 1 - The territorial context

2.2. Anamnesis. History profile

The most ancient and primary source, which describes the Patirion is the "βιος" of the blessed Bartholomew Simeri, founder of the monastery. After the Norman conquest of byzantine Calabria, on mystical suggestion of the Maria Virgin, he founded the monastery with the support of several Norman barons. When he returned from Rome, where he was received in great honor and receiving magnificent gifts of codes, icons, and utensils for the fledgling monastery, Bartholomew led at the end of the construction of the church and monastery, whose origin must be placed so between 1101 and 1105 [6,7].

The monastery, originally dedicated to Santa Maria Nuova Odigitria, was then known as "Patirion". It soon acquired large reputation due to its scriptorium (site in which important documents were written manually transcribed) which produced, among other books, hundreds of codes, many today stored in the Vatican Library, in the Abbey of Grottaferrata and other libraries around the world. With the turn of the 15th century begins the decay of all byzantin monasteries; in the 16th century, after some negative events as earthquakes, the church was closed. The available sources shows that the church underwent a restoration in 1672 with a consolidation of the temple and the great hall [8,9]. Renovations were made in 1705 and in 1752 with the construction of a magnificent marble altar topped with the image of Hodigitria Saint.

In the last century the church was restored, especially in the roofs, by local lords and catholic people.

In 1915 the ancient building was sold; currently it is Italian State ownership and it is managed from the Corpo Forestale (Forest Department) of Cosenza.

C. 2.3. Architectural description and materials constitutive

It should be noted that the church, over the years, has been subject of works that changed the original shape. The literature sources tells us that the front was originally provided by three major doors. Today there is just one. The rose window above the door is modern, the small one at the peak apex is ancient and it was built with white and yellow alternating stones. A stone portal emerges, with an ogival arch, supported by sandstone columns, with decorated capitals; two little windows in correspondence to the side aisles, complete the austerity of the church façades (Fig. 2).

Fig. 2 - View of main church

The opposite side is characterised by three circular apses of Arab-Norman style, with plant to semicircle, the central one with ampler dimension compared to the others two as the aisles **(fig.3).** The apses are expression of chromatic taste exquisitely oriental decorations and even color are found in the lateral portals.

Fig. 3- Exterior apses of the church

Fig. 4 - Apses details: pilasters and windows

A series of blind arches scanned at the rate of five by pilasters resting on high plinth, runs instead, the three apses and each arches is decorated, in turn, by a round that encloses a star pattern made with weave of various color

Fig. 5 - Doors ond side walls

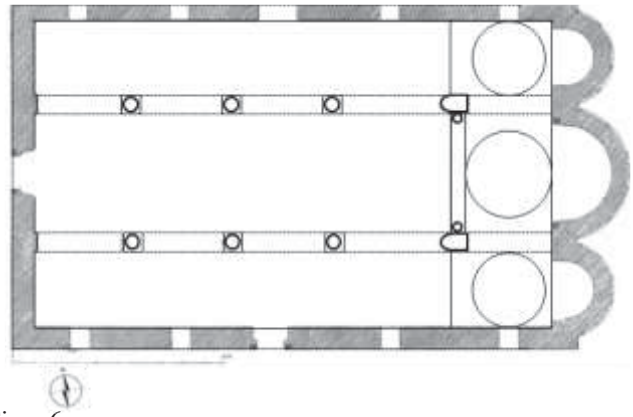
The effect is that of a lively and evocative polychrome lace [10, 11]. On every of the two side walls, in central position, a front door is situated. One of them, flanked two columns, has in summit a ferrule with an original arrow motive, while on the other one, also flanked by two columns with capitals and decorated shelves, take place an original decoration with stylized flowers (Figs. 4 and 5)

The church is characterized by a rectangular Latin-Norman plan (27,20 m long, 14,35 m wide) , with three apses facing the East. It has three naves, an ampler central and two side smaller, oriented from west to east (Figs. 6).

They are characterized by wooden roof trusses, and are separated laterally by two rows of arches slightly pointed resting on stone pillars, deprived of marbles, decorations and any ornament [12, 13].

The presbytery is slightly up from the body of the church, and it is bounded by four pillars that are pulled over four columns, in decorative function, with Corinthian capitals probably coming from the ruins of the ancient Thurio city.

At the entrance of the church there is an ancient mosaic floor dating back to the 12th century, made using mainly blocks of limestone and hard colored Calabrian stones; four figures of fantastic animals are represented (a large centaur, a horse, a winged griffin and a feline) enclosed in roundels with an identical repertoire of minor forms minor forms.



Fig…6

III. METHODOLOGICAL APPROACH

Every architectural structure, exposed to varying weather conditions, is subject to degradation and thus to a deterioration of the structural conditions due to wear or external agents actions. It is possible to distinguish different pathologies that hit in a more or less serious the building [14,15]. In the case of Patirion other events have been acted, as different earthquakes occurred over the centuries, and many renovation works that have partially altered the structure. Although today the monumental building appears in a fairly good state of preservation, it is possible to notice the presence of biological elements on some rocky wall, as observed in Fig. 21.

Referring to the technical rules UNI-Normal 11182 – 2006), in a degradation analysis survey, different kind of damage can be observed:

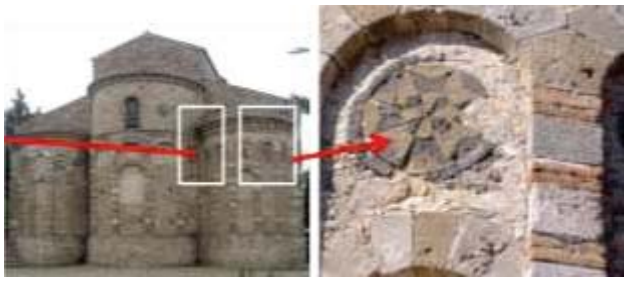
- Changes without significant performance degradation (for instance biological layer);
- Changes in substantial loss of material (lack or gap);
- Changes leading to loss structural (detachment);
- Presence of weeds.

In order to analyze some of these aspects, it is it well to operate laboratory analysis on a sample, starting through two preliminary phases like the visual observation and the collecting of meaningful samples of constituent materials. In the following, a scientific approach is illustrated with reference to biological deterioration cases on the surfaces of the building [17].

3.1 Short description of the main deterioration surfaces

The superficial degradation due to the external agents that affects different parts of the surfaces appears in a diversified way (Figg.7-9); it can be clearly noticed the action of pulverizing of mortar joins, bricks breakups and infiltrations of rising damp [18]. bricks degenerative processes have led to a very unusual deterioration typology; they have allowed an erosion in such a way as to highlight tiny fragments of materials used in the construction phase. Other building surfaces, because of the presence of damp patches, are characterized by a widespread and specific bio-deterioration, related to the

activity of micro-organisms that has also led to slight and localized forms of alveolar erosion [19].



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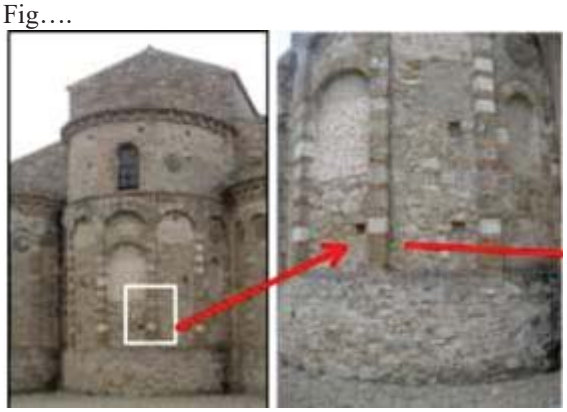


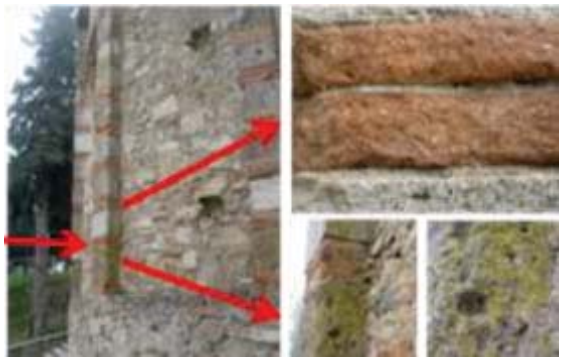


Fig.

Fig. 9 - Façade

3.2. Constituent materials. Sampling for laboratory

The study of historical-monumental buildings implies not only the knowledge of exterior, esthetic and structural aspects, but also a specific attention to the constituent materials. It is necessary to perform studies on the materials through surveys on samples, withdrawn preferably by non-destructive ways [20.21.

In order to illustrate the method, with reference to the Patirion Church, some representative samples have been collected, avoiding to affect the integrity of the monument; they are part of already detached fragments of mortar and brick from the apse of the building and from a side wall.

Figures 10 and 11 show the original position of two representative samples in the building and a photographic enlargement of the same samples (Fig. 10,11).

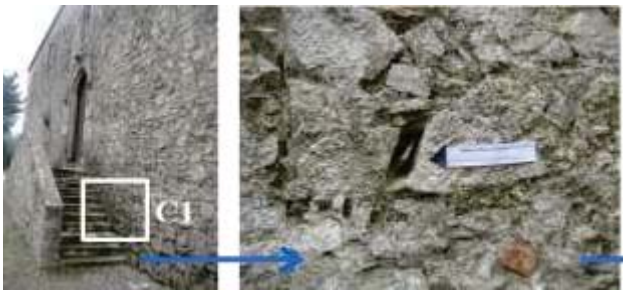


Fig 10

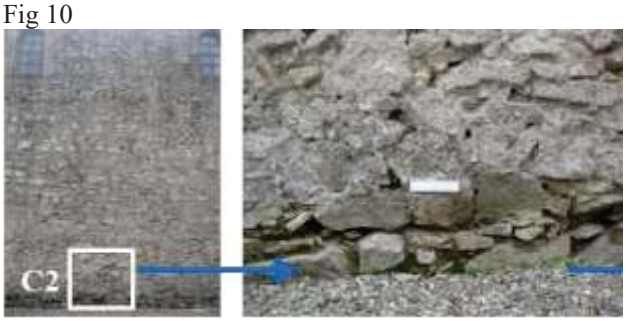


Fig.11

3.3. Laboratory tests

The sample materials have been used to make thin sections for observations under a polarized microscope, and prepared for the Scanning Electron Microscope (SEM) vision too.Specifically, as the sample easily crumble, before to make the cut for the extrapolation of the section, it was submitted to an into resin encapsulation process to make it more compact. The section is obtained from a cross-section by abrasion until to assure uniform thickness (30 μm) and allow observation under polarized light microscopy and deduce a petrographic and mineralogical characterization. For the chemical and morphological analysis by means of the SEM, the preparation of the sample to be examined is carried staring it on a specific aluminum plate and subjecting it to the so-called metallization. It is possible, in this way, to obtain both a detailed morphological analysis and a chemical analysis of main elements present in the sample. Here following the tests and the derived results are illustrated, concerning specifically the two selected samples, named C1 and C2.

Sample C1

The investigations carried out on the sample C1 integrates allowed determining the origin of the alkaline silicate rock. The observation by the SEM has allowed to notice an isotropic texture with crystals isodiametric well formed, which have contours closely intermeshing. The contours

of the majority of the crystals are characterized by alterations due to the oxidation phenomenon of alkali feldspar, as more easily degradable (Fig.12, a, b, c). From the petrographic point of view, granite consists mainly of quartz, feldspar, mica, pyroxene, amphibole and olivine.

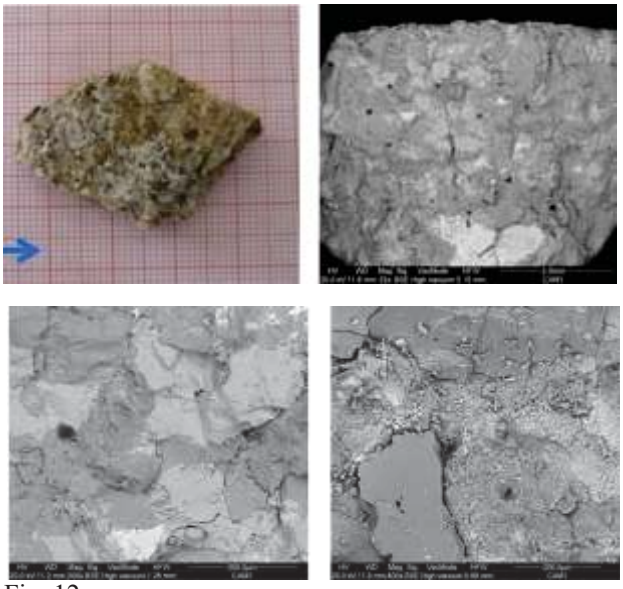
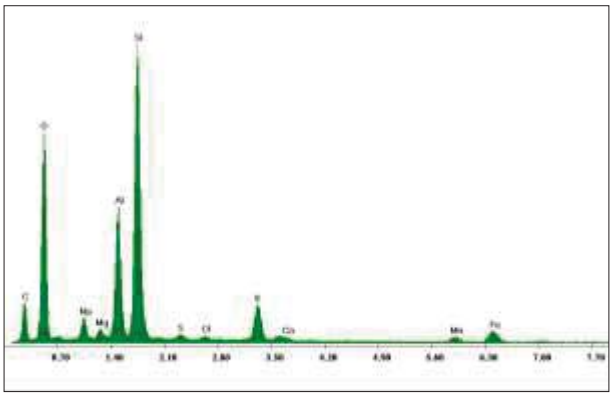


Fig. 12

The survey chemical test on the sample C1 reveals a high proportion of silica (Si), aluminum (Al) and other elements characteristic of the granites (Fig. 13), while the alteration is characterized by typical products of this kind of stone, as sulfides, chlorides and salts (Table A).



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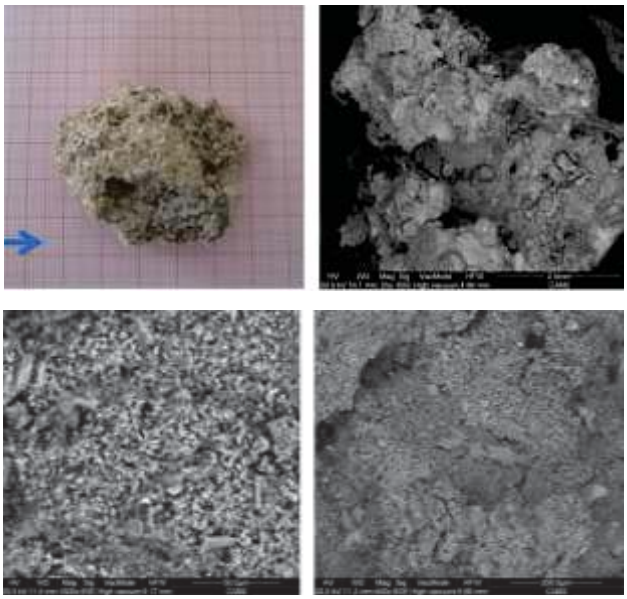
Camp	Na2O	MgO	Al2O3	SiO2	SO3	Cl2O	K2O	CaO	MnO	Fe2O3
C1	Percentage (%)									
	4.58	1.97	20.39	57.12	1.37	0.53	5.75	0.48	1.93	5.88

TABLE

Sample C2



Fig….14

The investigations carried out on the integral part of the C2 sample allowed to determine the magnesium calcitic origin of the mortar which is very porous.

Observation by SEM has allowed to notice a microcrystalline matrix with unselected crystals of quartz and feldspar constituting the aggregate. In addition, the sample presents fractures, and biological and chemical alterations (Fig.14, a, b, c).

From the images we can see the presence of hyphae and algae present inside the mortar with the surface characterized by a biological (Fig. 15, a, b, c). The chemical alteration is due to the phenomena of dissolution and recrystallization. The chemical tests carried out on sample C2 reveals a high percentage of calcium oxide, less magnesium and other characteristic elements of air mortars (Fig. 16, Table B)

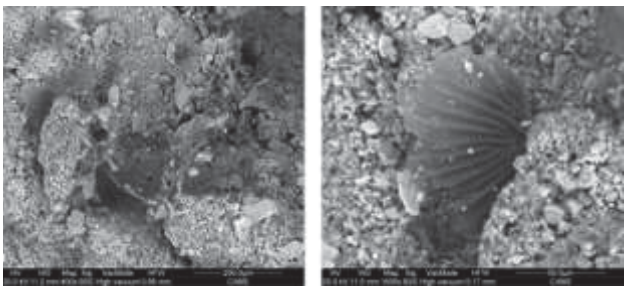


Fig. 15 - Micro-photos SEM - EDS of C2 sample a) biological deterioration detail, b) algae presence

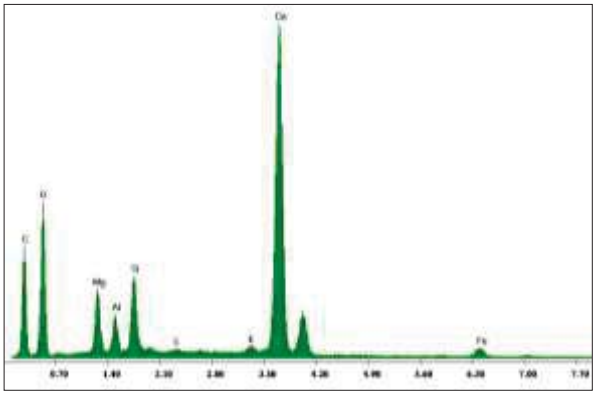


Fig. 16 - Diagram SEM-EDS with the present mostly elements in the mortar

Camp	MgO	Al2O3	SiO2	SO3	K2O	CaO	Fe2O3
C2	Percentage (%)						
	11.64	6.56	14.99	0.71	1.11	60.22	4.77

Table B – Anhydrous values of the greatest

IV. CONCLUSIONS

The research basis of a good architecture includes interdisciplinary arts and sciences that converge in full characterization of the building.

This evidence is valid too for restauration actions of historical monuments. The article proposes the results of a research aimed at supporting a conservation work and enhancement of a monumental cult building of the Byzantine era.

In particular it was first mapped out a profile amnesic full architectural description and photographic dossier; different analyses to characterize the stones mostly used to build the church were later carried out; the focus of study has been on the conservation state of façade walls and their characterization. Some basic analysis for a first diagnostic approach on the characterization of materials and their state of conservation have been illustrated. From macroscopic description, with the definition of the structural and textural aspects, the focus has been addressed to the degradation by the scanning electron microscope (SEM) observation of some samples and the chemical characterization of the material. The investigations carried out have allowed to identify the materials constituting the church and the stones types used in the past, and many useful information about deterioration phenomena, as fractures, materials erosion, biological and chemical degradation.

Obviously the adopted methods of investigation, as the analysis by scanning electron microscope, are just some of the preliminary analysis alongside other diagnostic methods for further developments and useful information capture for a better understanding of the samples and then to orient the best conservation of the monuments.

References

[1] Gattuso C., Knowledge and Innovation in the Field of Cultural Heritage- XIII International Forum Le Vie dei Mercanti - Best practices in heritage conservation management. p.1176-1179, Napoli, 2015.

[2] Crisci G. M., Gattuso C., Miriello D., Un manuale per una diagnostica intelligente, Contributo a Convegno Arkos - La diagnostica intelligente, Rende, 2007.

[3] Gattuso C., Per un approccio razionale al piano diagnostico, II Convegno Internazionale AIES - Diagnosi per la conservazione e valorizzazione del Patrimonio Culturale, Ethos ed., Napoli, 2011.

[4] Gattuso C., Cozza R., Gattuso P., Villella F., La conoscenza per il restauro e la conservazione, Franco Angeli, Roma, 2012.

[5] Gattuso C., A coordinated and multi-step approach for conservation and enhancement of built heritage, III Convegno Internazionale AIES - Diagnosi per la conservazione e valorizzazione del Patrimonio Culturale, Ethos ed., Napoli, 2012.

[6] Gattuso P., Gattuso C., Crisci G.M., La ricerca storico-architettonica nel contesto del piano diagnostico, in Archeomatica, n.1, A&C2000 editore, Roma, 2010.

[7] Crisci G. M., Gattuso C., Miriello D., Un manuale per una diagnostica intelligente, Contributo a Convegno Arkos - La diagnostica intelligente, Rende, 2007.

[8] Orsi P., Le chiese basiliane della Calabria, Vallecchi editore, Firenze 1929.

[9] Gaetani O., Vitae sanctorum Siculorum, Palermo, 1657, II, page 136.

[10] Battifol P., L'abbaye de Rossano, contribution à l'histoire of the Vatican, , Paris 1891.8, pp.XL, 182.

[11] Candido M., Santa Maria del Patire e la Cattolica di Stilo con esempi di chiese bizantine e basiliane in Val di Crati , Ed. Ferrari Ediore - Rossano Calabro, 2014.

[12] Renzo L., Il Monastero Santa Maria del Patire di Rossano, Edit. Progetto 2000, Cosenza, 2003.

[13] Martino C., Santa Maria del Patir presso Rossano in Calabria bizantina, Roma, 2003 pp 70-72.

[14] Scaduto R., Tutela e restauri in Sicilia e in Calabria nella prima metà del Novecento, Roma, 2016.

[15] Raccomandazioni Normal n.1/88, Alterazioni macroscopiche dei materiali lapidei: Lessico, Istituto Centrale del Restauro, Roma, 1988.

[16] Gattuso C., Gattuso P., Crisci G.M., A numeric method for the quantitative evaluation of the deterioration of the surface of a monumental building - Science and Technology for Cultural Heritage, Issue no. 18, Serra ed., Pisa/Roma, 2009.

[17] Morbidelli L., Le rocce e i loro costituenti, Bardi Editore, Roma 2003

[18] Accardo G., Vigliano G., Strumenti e materiali del restauro. Metodi di analisi, misura e controllo, Edizioni Kappa, Roma, 1989.

[19] Matteini M., Moles A., Scienza e restauro, Nardini Editore, Firenze, 2003.