

Editorial

Special Issue: Results of the II National Research Project of AIAR: Archaeometric Study of the Frescoes by Saturnino Gatti and Workshop at the Church of San Panfilo in Tornimparte (AQ, Italy)

Anna Galli ¹, Maria Francesca Alberghina ^{2,*}, Alessandro Re ³, Donata Magrini ⁴, Celestino Grifa ⁵,
Rosina Celeste Ponterio ⁶ and Mauro Francesco La Russa ²

¹ Department of Materials Science, University of Milano-Bicocca, Via R. Cozzi 55, 20125 Milan, Italy; anna.galli@unimib.it

² Department of Biology, Ecology and Earth Sciences (DiBEST), University of Calabria, 87036 Arcavacata di Rende, Italy; mauro.larussa@unical.it

³ Department of Physics, University of Torino, Via Pietro Giuria 1, 10125 Turin, Italy; alessandro.re@unito.it

⁴ Institute of Heritage Science, National Research Council (ISPC-CNR), Area della Ricerca Firenze, Via Madonna del Piano 10, 50019 Sesto Fiorentino, Italy; donata.magrini@cnr.it

⁵ Department of Science and Technology, University of Sannio in Benevento, Via De Sanctis snc, 82100 Benevento, Italy; celgrifa@unisannio.it

⁶ Institute for Chemical-Physical Processes, National Research Council (IPCF-CNR), V. le F. Stagno d'Alcontres 37, 98158 Messina, Italy; ponterio@ipcf.cnr.it

* Correspondence: francesca.alberghina@gmail.com



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1. The AIAR Project

The archaeometric study of the frescoes by the painter Saturnino Gatti (1463–1518) in the apse of the Church of San Panfilo in Villagrande di Tornimparte (L'Aquila) was the subject of the II National Research Project [1] conducted by members of the Italian Association of Archaeometry (AIAR). The research activities were carried out as part of a scientific agreement of the AIAR, signed in 2020 by the Abruzzo Regional Secretariat of the Ministry for Culture and Superintendence of Archaeology, Fine Arts and Landscape for the provinces of L'Aquila and Teramo. Several non-destructive in situ investigations and laboratory analyses on micro-fragments sampled from the different levels of the pictorial cycle were carried out thanks to the co-working of 21 Research Groups, with more than 60 AIAR researchers involved in the different stages of scientific studies of pictorial materials and of the environmental conditions in which the frescoes are now preserved.

The present Special Issue is an important opportunity to illustrate for the first time the results of the pre-restoration diagnostic study. The research project for the archaeometric study of the cycle of frescoes by the painter Saturnino Gatti (Figure 1) was carried out through the application of analytical methodologies made available by the Research Groups as members of the AIAR. The technical–scientific study of the pictorial cycle at the church of San Panfilo was aimed at providing useful indications both from a purely cognitive point of view, as a deepening of the artistic technique of the painter and his collaborators, and from a conservative point of view. In fact, the knowledge of the materials and the evaluation of the state of conservation are essential to supporting and guiding the methodological approach for the future planning of restoration works of the frescoes, helping to guarantee the principles of sustainability, durability and compatibility of the materials on which a correct conservative approach is based.

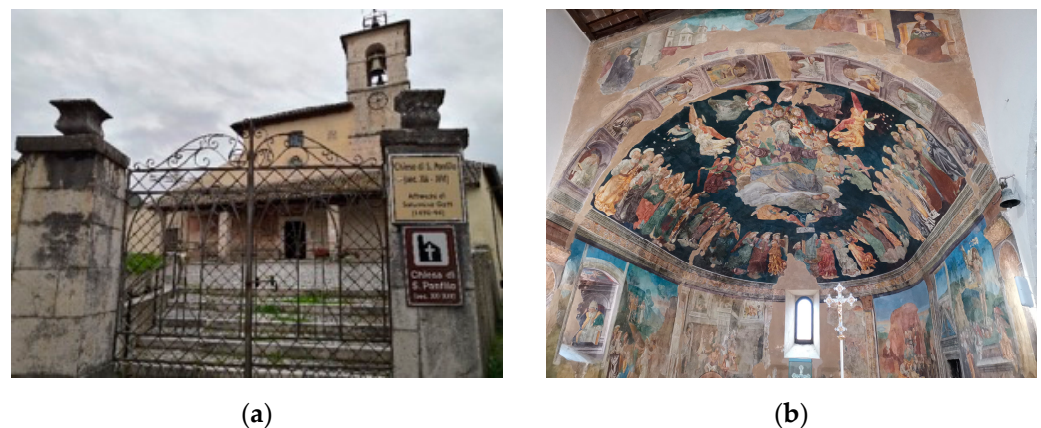


Figure 1. (a) Church of San Panfilo in Villagrande di Tornimparte in the province of L’Aquila. (b) Cycle of frescoes in the apse by Saturnino Gatti (1463–1518) object of study and research activities.

The scientific investigation campaign, whose methods and results are described in detail in the articles of this Special Issue, was identified following the technical inspection carried out by the restorers and art historians. This preliminary phase was aimed at understanding the needs in terms of knowledge and conservation features, the extension of the areas to be investigated for the documentation of the degradation and the management methods of the in situ and laboratory investigations.

The macro-objectives followed by the working groups coordinated by the Scientific Board of AIAR were:

- to document the state of conservation of the architectural building and the painted surfaces;
- to analyse the microclimate and the level of inertia of the church in relation to external conditions;
- to understand the degradation phenomena of the pictorial surfaces and the masonries;
- to identify and map materials of previous restoration works superimposed onto the original pictorial surfaces;
- to characterize the original materials and pictorial techniques (“a fresco” vs. “a secco”);
- to identify the artistic technique and typical features of Saturnino Gatti and the other painters who worked in San Panfilo church.

In detail, the activities and the objectives addressed after a fruitful dialogue with staff delegated to the conservation and safeguarding of the cycle of frescoes are those illustrated below:

- A. Digital photogrammetric surveys aimed at the documentation of the state of conservation of the architectural artefact and the paintings. The fully non-invasive technique guarantees the robust restitution of three-dimensional geometries and a high-resolution rendering of the pictorial surface. The obtained photorealistic 3D digital model can be used not only for mere documentation purposes, but also as a measurable support for diagnostic mapping. Moreover, the 3D model, deriving from a replicable photographic process, will allow researchers to quickly and effectively document the pre- and post-intervention.
- B. Microclimate monitoring and analysis of the level of inertia of the building with respect to external conditions. The acquisition, processing and analysis of thermo-hygrometric values for the assessment of environmental conditions allow researchers to: (i) detect the condition of the thermo-hygrometric parameters, temperature (T , °C) and relative humidity (RH, %); (ii) compare the measured values with the microclimatic parameters for the correct conservation of the artefacts of different nature identified by the Recommendation [2,3]; (iii) analyse the daily ranges of temperature and relative humidity and compare them with the values indicated by the Recommendation [2,3] in order to evaluate the influence of the conservation conditions;

- (iv) calculate the dew point temperature values for highlighting the condensation phenomena; and (v) indicate any corrective measures (active or passive) for reaching the thermo-hygrometric parameters for correct conservation.
- C. Mapping of the restored areas and identification of the restoration materials that overlapped during past documented and undocumented conservation interventions. Through the integration of diagnostic imaging techniques and spectrometric analyses, the areas affected by repainting, remakes, stuccos, and protective materials applied to the original surfaces have been localized in detail. The characterization of these overlapping materials provided a guide to assess applicable treatments and the removal of materials that compromise the durability of the original layers. Particular attention was paid to understanding the blue background layer on the vault surface, heavily darkened, to evaluate what the original appearance was and how many layers and which materials were superimposed over time (Figure 2).



Figure 2. Details of the vault affected by a dark blue background and comparison between the current conditions and the ICR pre-intervention status in a historical image (**bottom right**), taken from Archivio storico e Archivio fotografico della Soprintendenza Archeologia Belle Arti e Paesaggio di L'Aquila e Teramo.

In fact, the site has undergone various restoration interventions over time, not all of which have been documented, that have variously attempted to address the conservation issues and have had aesthetic results that were not always respectful to the formal and stylistic reading of the original figurative complex (Figure 3). At a first macroscopic evaluation, these interventions were faced with different criteria from time to time, generating a palimpsest that needs to be reconstructed for a correct diachronic and stratigraphic interpretation of the remakes in relation to the original layers still present under the repaintings. The interpretation of the diagnostic results constitutes objective support for evaluating the removal of areas of renovation which currently partially or totally hide traces of the Renaissance frescos.



Figure 3. Examples of typical alterations found in the lower and upper portions of the apsidal basin.

- D. Characterization of the original materials of the “a fresco” area and any “a secco” layers, including both inorganic (pigments and plasters) and organic (binders, additives, etc.) constituents. The identification of the palette in the various scenes of the pictorial cycle could allow researchers to evaluate the presence of different “interventions” or periods, providing art historians with further data for an objective identification of the portions attributable to the Saturnino Gatti workshop, to date hypothesized only based on historical–stylistic features.
- E. Study Saturnino Gatti’s artistic technique and the organization rules of his workshop by obtaining information on the techniques of transporting the drawing and the construction of the figurative system, in an attempt to identify operational peculiarities that could distinguish portions painted by Saturnino Gatti from those painted by collaborators. During the preliminary inspection, it was possible to observe the complex system of engravings, particularly in some exposed areas due to the partial or total lacunae of the pictorial layer (Figure 4). Furthermore, in a close view of the surfaces, the typical dots of the “spolvero” technique are visible.

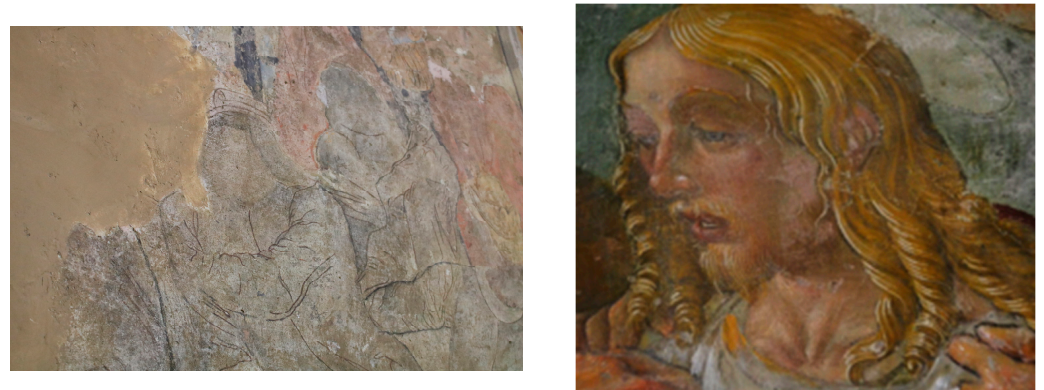


Figure 4. Examples of the several engravings visible both in the pictorial portions characterized by total collapse and in those with a good state of conservation.

This first evidence was deepened during the in situ photographic and multispectral investigation. This diagnostic approach based on multispectral imaging also allows for a better iconographic interpretation, highlighting the volumetric effects of the figures and the perspective relationships altered by degradation phenomena or repainting that has overlapped over time. Furthermore, in order to obtain a deeper identification of artist technique and understanding of the technical choices of the workshop, the study envisaged the characterization of the plasters (number of layers, type of aggregates, binders, presence of primers, etc.) through mineral–petrographic analyses.

- F. Documentation, mapping and understanding of the phenomena of degradation (current or pre-existing) of the pictorial surfaces and the architectural structures on which

they stand (Figure 5). This phase of the study returned a lot of fundamental information to document the different types of degradation, to guide the design choices and to guarantee the durability of the future restoration intervention. In fact, suitable analytical methodologies were used to locate the pictorial or wall areas affected by water infiltration from windows or roofing and capillary rising damp.

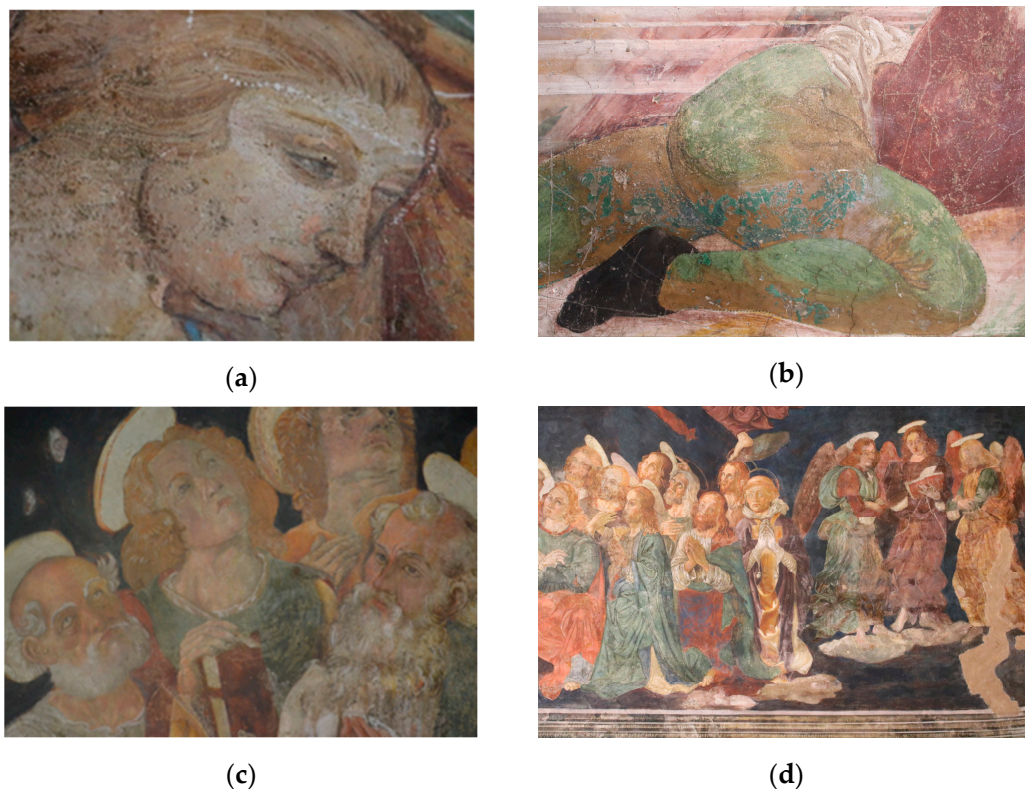


Figure 5. Details of the alterations observed at the different levels of the pictorial surfaces: (a,b) details of the pictorial surfaces altered along the apse; (c,d) details of the alterations affecting the pictorial surfaces of the vault.

Analyses of soluble salts which generate efflorescence (and/or sub-fluorescence) were also conducted. The identification of salts allowed for understanding the degradation phenomena in progress that involve the constituent materials or external compounds introduced by the surface migration process, in order to evaluate the appropriate removal treatments. The study of the cross-section evaluated the degradation effects generated by crystallization and solubilization on the original portions and on the integration of mortars implemented during the numerous previous interventions applied to the site during the 20th century, while also considering the external and internal climatic conditions. With regard to the plasters and the pictorial layer, compositional and stratigraphic investigations (in situ and in-lab) were carried out aimed at understanding the phenomena of chromatic alteration or selective detachments, both in relation to current or past conservation conditions and to the peculiarities of the artistic technique.

To achieve these objectives, the study was performed, in the first phase, via in situ /non-invasive techniques using portable instrumentation and, successively, by means of micro-destructive analyses on samples collected from accessible surfaces. The integrated multi-analytical approach was selected due to the complementarity of the expected results as well as minimizing the number of samples, guaranteeing as much as possible the integrity of the surfaces analysed.

The non-invasive analyses, performed on the pictorial layers of the whole apse, involved: (1) photogrammetric surveys based on computer vision algorithms integrated with SfM (Structure from Motion); (2) measurement and monitoring of thermos-hygrometric

parameters; (3) multispectral investigations—infrared reflectography (IRR), false colour infrared (FC-IR), imaging of luminescence in the visible induced by ultraviolet (UVL) lighting; (4) hypercolorimetric multispectral imaging (HMI); (5) digital optical microscopy in visible and ultraviolet light; (6) traditional and/or pulse compression IR thermography (PuCT, pulse-compression thermography); (7) X-ray fluorescence spectrometry (XRF); (8) external reflectance Fourier transform infrared spectroscopy (ER-FTIR) and/or total attenuated reflectance (ATR-FTIR); and (9) Raman spectroscopy.

On the other hand, the micro-destructive techniques on fragments selected on the basis of the first results of the in-situ investigations concerned: (1) Raman spectroscopy and surface-enhanced Raman scattering (SERS); (2) polarizing optical microscopy (OM) and scanning electron microscopy with microanalysis (SEM-EDS) on thin and polished sections; (3) ion chromatography for the analysis of soluble salts; (4) X-ray diffraction analysis (XRD); and (5) mass spectrometry analyses.

Figure 6 showed the sampling areas of the 47 micro-fragments sampled from the apsidal basin and on the central part of the vault. In particular, the five pictorial panels were been identified with the letters A, B, C, D, E as follows:

- Panel A—first painting from the left of the apse basin, depicting “Christ in the Garden of Gethsemane”;
- Panel B—depicting the “Coronation with Thorns”;
- Panel C—depicting the “Crucifixion” (no longer visible due to deterioration and previous interventions);
- Panel D—fourth panel from the left of the apsidal basin, depicting the “Lamentation over the Dead Christ”;
- Panel E—fifth panel from the left of the apse basin—Resurrection;
- Vault—central part depicting “God the Father Blessing”.



Figure 6. Panels (from left of the apse) (A–E) and (vault): Location and denomination of the areas where the 47 fragments of plaster and pictorial layers were taken. Each sampling areas have been selected on the basis of the first results of the in-situ investigations.

The following section describes the history of the building and the most relevant historical aspects about the frescoes (patronage, chronology, iconographic programme, and artistic reference models), information useful for the understanding and contextualization of the results provided by the project.

2. Saturnino Gatti's Frescoes in Their Historical Context by Saverio Ricci (Ministero della Cultura, Soprintendenza Archeologia, Belle Arti e Paesaggio per le Province di L'Aquila e Teramo)

The church of San Panfilo in Villagrande (declared as a National Monument in 1902) is the only one, among the others located in the several small villages called “ville” belonging to the municipality of Tornimparte, that is still preserved in its original architectural shape. Founded around the year 1000, the church is preceded by a large, raised arcade inside of which are walled ashlar from the Roman Era and other fragments from the Middle Ages, including a stone that is engraved with the date 1471—in the opinion of some historians, this could be proof that the church was partially rebuilt after the earthquake of 1461. This belief was expressed by some authors [4,5], according to whom over the centuries the building was extensively reconstructed in those parts that had fallen because of historical earthquakes (among them, the Great Earthquake of 1703 and the Marsica Earthquake of 1915). The façade is bordered on the left by a sloping wall and on the opposite side by the bell tower; it appears to be of modest elevation due to its disproportionate width, having to cover the space of four naves, which are also flanked on the left side by another longitudinal room, practically the same size as the side nave, formerly occupied by the ossuary and used since 1832 as the Oratory of the Congregation of Our Lady of Sorrows. The part above the arcade was fully renovated in the 20th century, as can be seen by observing the rose window, no longer adorned with theories of small arches framing an orbicular light, but simply closed by a modern stained-glass window depicting the titular saint of the church, Saint Pamphilus, a long-time evangeliser, bishop, and patron of Sulmona who lived in the 7th century. The interior space is divided into four naves: two to the right, the central nave, and the left one. In the left aisle is the Chapel of the Crucifix and two altars dedicated to St Francis and St Pamphilus. In the first right aisle is the altar of the Nativity, while in the adjacent aisle are the chapel of the Visitation and altars dedicated to the Holy Rosary and St Joseph.

In any case, the building's fame is mainly due to the cycle decorating the apse, which was commissioned by the Community to the painter Saturnino di Giovanni di Gatto, born in the nearby village of San Vittorino (nowadays in the municipality of Pizzoli). It has been possible to establish the chronology of the cycle in a rather precise manner, since the archival findings delimit with a good margin of precision the interval within which Saturnino Gatti executed the decoration of the apse. The first document is dated 23 May 1489, a payment mandate with which Saturnino received forty-five florins from “Dominico Antoni Paulutii de Tornamparte” for the frescoes to be painted in an unspecified chapel in the church; on 1 May 1490, the commissioned artist signed the contract to paint the apse of the same church; on 19 April 1491, the “massari” of Tornimparte procured the money to be paid to Saturnino for the work in progress, renting the pastures of Villagrande for three seasons; the last balance for the paintings is dated 12 December 1494, but already in February, two renowned masters, Silvestro dell'Aquila and Sebastiano di Cola da Casentino, had been called “ad pretiandum picturam”, i.e., summoned to the site as experts to estimate the completed works in the “cappella sive tribuna in dicta ecclesia” [6]. Some historians have argued that these were two separate commissions, but the most complete transcription and interpretation of the documents carried out by [5,7] seems to have removed any doubts in this regard, demonstrating that the documents transcribed are related to the same decorative enterprise: the payment received in 1489 should be interpreted as an advance payment, and the work was carried out from 1491 to 1494, as also stated by Gatti's most authoritative scholar, Ferdinando Bologna [8].

Turning to the topic of narrative structure and subjects illustrated in the cycle, note how the apsidal dome hosts a representation of Paradise with the imposing figure of God the Father Blessing at the centre of the vault, surrounded by the apostles and male saints (on his right), the Virgin Mary and female saints (on the left side), a whirlwind of Cherubs arranged around the perimeter of the mandorla within which God the Father stands out, angels in flight scattering flowers and a choir of fifteen musician angels, as evidenced by a

scroll containing a short fragment of a musical score supported by two angels with ribbons, which reads “Gloria in excelsis Deo”. The Gregorian chant evoked belongs to an ancient mass, dating back to the 11th century, widely used in the Catholic liturgy [9]. The apsidal basin originally featured the following scenes from the Passion of Christ divided into five panels, depicting in the following order, counter clockwise: (1) Capture of Christ in the Garden of Gethsemane; (2) Coronation with Thorns; (3) Crucifixion (?); (4) Lamentation over the Dead Christ; (5) Resurrection.

Of the original cycle, the first, fourth and fifth panels remain intact, while the second was completely repainted, including the faux architecture framing it, probably in the second half of the 17th century. The third panel, on the other hand, is almost entirely lost, also due to the unfortunate opening, in uncertain times, of a large window to allow light into the room. It is interesting to observe the iconographic complexity of the first panel, which hosts two other episodes secondary to the main scene, closely connected to it but chronologically to be fixed before the moment in which the Capture of Christ takes place. These are: (a) the Kiss of Judas, in the background and characterised by the presence, never noted before, of a turreted city seen from a distant point of view, identifiable as Jerusalem, concealed by a thick veil due both to the Saturnino-esque use of aerial perspective (and thus the desire to artificially recreate the effect of atmospheric haze), and to the accumulation of particles on the paint film; (b) St. Peter amputating Malchus’ ear—in this case, Saturnino placed the figures in the foreground, although the episode was narrated as contemporary with the betrayal perpetrated by Judas, thus preceding the moment when Jesus, after having healed the servant of the High Priest mutilated by the apostle, hands himself over to the Sanhedrin guards, as told in the Gospel of St. John.

The Stories of the Passion are anticipated, on the left side, by a mock niche within which stands, with a harsh and angular physicality and in a sharply characterized posture, Saint Vitus the martyr accompanied by two dogs, whose presence is explained by the great popular devotion paid to the thaumaturge saint, especially in the territories with a prevalent pastoral economy (it is no coincidence that Abruzzo, Molise and Apulia, regions of transhumance, are still strongholds of his cult). Given that shepherds lived in close proximity with domestic animals, the saint was invoked against dog rabies and the bite of poisonous animals. It should also be pointed out that in Colle San Vito, a hamlet very close to Villagrande, inside the church consecrated to St Vitus is conserved a wooden statue of the saint attributed to Saturnino Gatti in recent contributions [10,11]. Two Doctors of the Church, St. Jerome and St. Ambrose, are portrayed in the window gaps behind the first panel, while above the opening, in the upper intrados, is painted the famous “IHS” Christogram inscribed in a sun (an invention of St. Bernardine of Siena), very popular in the Abruzzo Apennines due to the enormous veneration that the Franciscan preacher enjoyed at an early age in L’Aquila. Also note the detail that develops from the base of the left side niche: at this point, there was a trompe-l’oeil-painted carpet unrolled downwards, of which unfortunately only the yellow-coloured base and some faint preparatory traces of the arabesque weave design remain visible. Its presence recalls a customary tradition of Renaissance painting, especially in the Adriatic area, between Venice and the Marches (oriental carpets were imported in the country via the ports on the Adriatic Sea).

On the right-hand side, the cycle is concluded by another mock niche containing the figure of Fra Pietro dell’Aquila, a Franciscan theologian and philosopher native to Tornimparte, better known by the Latin pseudonym “Scotellus” (it. Scotello). This inclusion may have different explanations: the affection of the inhabitants towards their illustrious fellow citizen, to whom the Community—the commissioner of the works—wanted to pay visible homage. In another hypothetical scenario, Scotello’s commentaries on the Holy Scriptures were, probably, the source of inspiration for the cycle, or guided the selection of the peculiar episodes of the Passion of Christ that formed the basis of the iconographic programme. A third hypothesis, finally, leads us to interpret the choice as a precise symbolic intention, the dichotomy between Faith and Reason, identifying in Saint Vitus the emblem of an irrational credence bordering superstition, and in Scotello the simulacrum of humanist thought.

The arch above the high altar is decorated with eight figures of prophets looking out from false niches that illusionistically open in the surface of the subarch, while on the extrados of the same triumphal arch we find a large representation of the Annunciation, surrounded by urban scenery that can be interpreted as a view of L'Aquila, in which the primordial Basilica of San Bernardino da Siena is clearly recognisable: the imposing dome, the highest ever built in Abruzzo at that time, was in fact completed in 1489 and therefore was emphatically depicted by Gatti just a few years later [12]. All the paintings are framed by faux perspective architecture, elements of exceptional artistic value, designed and composed according to the Renaissance tradition: some of the best-preserved details are the Corinthian capitals, particularly that corresponding to the access door of the sacristy. In addition, a plinth of mock mottled marble slabs starting from the floor, above which rise grotesque decorated pillars surmounted by a continuous entablature, creates the overall effect of a series of openings onto external landscapes that break through two-dimensional space.

To conclude with a brief stylistic overview of the cycle, it is necessary to premise that the research has not yet fully shed light on the training of the artist from San Vittorino. Modern critics believe, almost unanimously, that Gatti, after an initial frequentation of Silvestro dell'Aquila's workshop (in 1477, when he was only fourteen years old, he appears as a witness in the stipulation of a deed with the executors of the will of Cardinal Amico Agnifili, concerning the allocation of the ecclesiastic's funerary monument in the Cathedral of San Massimo), in the following decade the artist stayed in Florence. Indeed, no activity is documented in the L'Aquila archives until 1488, when he undertook to paint a chapel in the church of San Domenico. For many reasons, his style appears to be increasingly linked to the teachings of Andrea del Verrocchio, although in the past, some art historians suggested recognising the influence of other great Renaissance artists such as Melozzo da Forlì, Antoniazio Romano and Pietro Perugino. I totally agree with the opinions of Ferdinando Bologna [13], Alessandro Angelini [14] and Michele Maccherini [7,15], who have dedicated some important studies, with very convincing insights, to that season of "verrocchismo aquilano" developed in the last thirty years of the 15th century, in which the Florentine extraction of Gatti's art has been emphasized when comparing certain details of the Tornimparte frescoes with Verrocchio's artworks. Saturnino, in the end, can rightly be defined as the most faithful interpreter of his master in Abruzzo. But this matter should be faced by scrupulously verifying derivations and affinities between Verrocchio's and Gatti's preparatory drawings, sculptures, and paintings, while also including various other Tuscan (and non-Tuscan) artists who, in the same period of Gatti's apprenticeship, received their artistic rudiments in Verrocchio's workshop, often perpetuating his expressive solutions, compositional ideas and executive techniques. Unfortunately, few and incomplete examples of Verrocchio's fresco paintings remain (essentially the detached fresco of San Domenico in Pistoia), which makes it more interesting to understand how much Saturnino's work is imbued with the technical notions he learnt alongside his master. For example, the use of calcium white spread even on partially dry plaster is very notable (Figure 7), and it is remarkable that it was also found in Luca Signorelli's frescoes in the Abbey of Monte Oliveto Maggiore (1497–1498) and at the Chapel of San Brizio in Orvieto's Cathedral (1499–1502), practically contemporary with those of Tornimparte.

Among the figures in the cycle more characterized for physiognomic data, postures, and expressiveness (and therefore most like Verrocchio's repertoire), angels, the risen Christ and sleeping soldiers in the Resurrection panel, the dead Christ and pious women in the Lamentation panel, Jesus and the apostles in the Capture of Christ panel can be identified. The saints in the vault and prophets in the sub-arch must also originally have shown much more refined features (see as an example Figure 8), appearing closer than today to the models of Verrocchio's school. Investigations have unequivocally shown, for example, that the extensive repainting of the sky in the Paradise background was carried out with Prussian Blue, which pertains to a modern restoration [16].



Figure 7. A comparison between Mary Magdalene in the Lamentation panel (**left**) and the detached fresco Madonna with standing Child (L'Aquila, church of Santa Margherita) (**right**) reveals identical executive technique in highlights made in “bianco di calce” (calcium white) for the finest details like the veils, and traces of gold leaf used for the gilding of halos and edges of robes.



Figure 8. Prophet Daniel appearing in the sub-arch reveals, through the comparison of pictures dating back from 1920 to 2020 (from left), the almost total loss of the “a secco” finishes located in the incarnate, eyes, hair and in the scroll held in the left hand.

Other retouches almost certainly took place at the same time, for which zinc white was used and therefore cannot be dated before the mid-19th century [17]. Another interesting aspect that emerges from the surveys is the possibility of recognising and consequently preserving the finishing touches applied “a secco”: the petrographic and chemical studies have demonstrated the tendency of Saturnino to apply colour corrections onto the dry plaster [18].

During the restoration phase, the cleaning should be approached with particular care and caution to remedy the serious errors of evaluation that were repeated in the cleaning operations executed in the 1950s and 1972 [19], because of which many exquisite details were removed due to the use of excessively invasive products. All these arguments, however, deserve further investigation when the planned restoration work is actually launched.

3. Results

The monitoring of the thermo-hygrometric conditions within the site was the very first step. The activity, organized into two main phases (intensive and continuous measurements), started in February 2021 and ended in April 2022 [20]. The microclimate characterisation inside the church, the comparison between average monthly indoor and

outdoor temperatures and the application of the EN 15757 standard [2,3] supply the restorers with information regarding the range of historical variability of relative humidity that should be respected during the restoration project.

With a view to supporting the work of the restorers, 3D photogrammetry, raking light documentation and mapping of the degradation phenomena affecting the painted surfaces of the apsidal conch were performed [21]. This fundamental step supplied relevant information on the conservation conditions, on the execution techniques and on the materials, but also helped in the selection of the points for sampling to perform subsequent laboratory analysis.

As far as the state of conservation of the painted surfaces is concerned, the decorated apsidal conch of St. Panfilo Church shows a significant overlap of damage pathologies probably attributable to both the executive techniques and the microclimate conditions of the site for which more detailed information can be found in many of the contributions in this Special Issue. Calandra et al. [22], by applying the sonic pulse velocity test, hygrometric tests, and infrared thermography, give some clues about the state of conservation of the frescoes, i.e., the combined system of plaster and wall support. The complete analysis of the frescoes' state of conservation revealed several areas of detachment or degradation phenomena. Thanks to the use of two analytical techniques (IC and ATR-FTIR) performed on micro-samples [23], it was possible to characterize the degradation due to salt crystallization. Specifically, efflorescence was mainly caused by newly formed crystals of gypsum and calcium carbonate, mainly due to the capillary rise from the ground, with the exception of the samples taken close to the window splays and from the vault, in which infiltration could be responsible. The bad state of conservation of these paintings could also be due to previous invasive restorations that affected the surfaces with heavy retouching and repainting. This is especially observed close to the openings of panel A and panel C, where modern mortar-based materials have been used, probably leading to the occurrence of the observed degradation phenomena [18]. After the investigations centred in the characterisation of the degradation phenomena, a diagnostic study was conducted aimed at the characterization of the executive techniques over the time, with particular attention being paid to the preparatory drawings, the original materials of the draft fresco and the occurrence of "a secco" finishes still present, both inorganic (pigments and plasters) and organic (binders and additives in the plasters or in the dry application to define the details of the representations).

The RAK photos [21] as well as the images acquired with imaging techniques [17] show the presence of incision marks (with minor pouncing) and the boundaries of "giornate" and "pontate", which clearly suggest the use of the fresco painting technique, although in several areas the colour spread was "a secco" [19,24,25], especially where colour loss is observed. The presence of a "morellone" layer under the blue-sky background for the scene depicted on panel E and under the vault confirms the use of the "a secco" painting technique [16].

The strong synergy between the in situ/non-invasive analyses [16] and the imaging techniques survey [17,21] performed on the same pictorial areas allowed an analysis of the quality of the punctual analyses results, demonstrating how a well-designed non-invasive campaign can drastically reduce the amount of sampling [18,19,24,25] necessary to obtain complete information on the materials and the artist's technique.

The palette of Saturnino Gatti comprises pigments, either used in their pure form or in a mixture, to create different hues that are all compatible with the coeval pictorial technique. Moreover, the non-invasive approach suggests the use of a gilding technique with a golden leaf adhered to a red bolus preparation in areas where it is no longer visible to the naked eye. Moreover, in addition to the original palette, the analytical protocol identified modern paint materials, such as Prussian blue, zinc white, copper, and chromium-based greens, used for numerous retouching. These results have been confirmed by petrographic and chemical analyses performed on microsamples.

The analyses of binders and restoration products revealed a variety of organic materials on the mural paintings, most of which are from past restoration interventions and have a synthetic origin. The overspread presence of paraffin is likely due to the application of

a mineral wax-based coating/consolidant. In particular, the execution technique encompassed the use of tempera-based paints, while retouched areas are characterised by the presence of oil-based resins [25].

The multi analytical approach presented in this Special Issue provided useful indications about both the materials and the executive techniques of the painter Saturnino Gatti and his collaborators, both to guide the methodological choices during the imminent planning of the restoration intervention.

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