Church of the Nativity of the Virgin, Gelati Monastery, Georgia

Wall painting conservation programme

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Wall Painting Conservators

Contents

Summary

The Gelati Monastery Complex is justifiably regarded as a masterpiece of medieval architecture, established in 1106 by King David IV, famously known as David the Builder. It is a religious and cultural landmark of inestimable significance, embodying the spirit of the Georgian Golden Age. At the heart of the monastery lies the Church of the Nativity of the Virgin Mary, the main cathedral of Gelati. It is renowned for its architectural sophistication, its 12th century mosaic at the east end, and its wall and vault paintings that cover its interior and associated chapels and entrances, spanning the 12th to 18th centuries. The Monastery is therefore a a repository that reflects the artistic and technical development of Georgian wall paintings over six centuries. The earliest paintings of the 12th century are among the finest in the country. The Gelati Monastery was inscribed on the World Heritage List in 1994.

Conserving the wall paintings in the Church of the Nativity is a complex and long-term undertaking. Extensive and severe deterioration and damage from moisture, salts and microbiology are prevalent and largely inherent problems. In response, a conservation programme begun in 2023 is being carried out according to rigorous, science-based criteria and is governed by recognized standards of theory and practice. It is underpinned by condition recording and assessment, investigation and analysis of original technologies and added materials, environmental monitoring and assessment, and specialist investigations and analyses of the major deteriogens (salts and biodeterioration). Conservation measures are selected to achieve greatest efficacy with least intervention and are focused on essential stabilization measures. International expertise is brought into the programme to carry out specialist investigations and analysis of salts deterioration and microbial colonization. Capacity building of the Georgian conservation team is a fundamental commitment and endeavour.

This document describes the foundation, development and implementation of the wall painting conservation programme between 2023–2025 and summarizes the many activities that have been carried out in this period. It also presents conservation measures, plans and timelines for addressing areas of critical concern. It concludes with a projected timeline of a wider range of conservation activities up to 2030.

Overview

The Gelati paintings are undermined by severe and extensive deterioration. This is not new but has occurred over centuries. The size and complexity of the Main Church and associated chapels and entrances present intrinsic risks of rainwater infiltration, which has happened repeatedly. Inherent salts are responsible for widespread disruption. Biological colonization and their adverse effects are endemic. Collected environmental data indicate variable and unstable conditions, which are not entirely controllable. Climate conditions that prevent some forms of deterioration potentially trigger others. Large expanses of painting therefore exist in altered and vulnerable states. Ongoing deterioration is a reality of the site and its inherited conditions.

The recent conservation history is dominated by reactive 'emergency' treatments that have often failed, causing more harm. This cycle of treatment failure must be broken if progress is to be made in preserving Gelati's wall paintings. Since 2023 a comprehensive and holistic programme of conservation has been developed and implemented under the direction of the Gelati Rehabilitation Committee. A conservation team of Georgians is led by UK conservators, Lisa Shekede and Stephen Rickerby, the authors of this document. With post-graduate qualifications in the specific field of wall painting conservation and over 30 years of direct, hands-on experience and project delivery, they have been responsible for conserving demanding wall painting sites worldwide.

Defining and delivering a sustainable conservation plan for the wall paintings is challenging. It requires recognition both of past failures and the many constraints on available options now. To move forward, it is important to make informed and dispassionate judgements on where efforts can and should be most constructively focused. To achieve these aims the foundation of the conservation programme is ambitious. For the first time in the monastery's history, all paintings throughout the church and the several side chapels and entrances are being considered. Comprehensive studies include condition recording and assessment, investigation and analysis of original technologies and added materials, environmental monitoring and assessment, and specialist investigations and analyses of the major deteriogens (salts and biodeterioration).

The wall painting treatment focuses on essential stabilization measures, carried out within a framework that privileges the compatibility and stability of introduced materials, and minimal intervention. Treatment planning, development and implementation are integrated and informed by continuing diagnostic studies, specific condition monitoring, and analytical and environmental data. As conditions of risk are being found on an ongoing basis, it is not possible to deal with all situations all at once. To accommodate this, a conservation plan that prioritizes risks and appropriate responses has been developed and is being realized.

The wall painting conservation programme is a multi-task endeavour, built from scratch. Establishing the programme on a professional basis was a fundamental starting point. Attracting and incorporating leading international scientific expertise is a major accomplishment that underpins the complex conservation measures required at Gelati. Recognising that inherent deterioration can only be managed by science-led diagnosis and mitigation measures is in line with best international standards and practice. Enabling a Georgian conservation team to eventually take over the task of preserving the paintings at Gelati is a key aim and undertaking. Each of these components is necessary but also ground-breaking.

Conservation projects of this scope, rigour and ambition are rare internationally, and certainly no conservation programme of this standard has been previously carried out in Georgia. The project provides an unprecedented opportunity to bring Georgian wall painting conservation to the forefront of international practice not only for the lifetime of the Gelati project, but into the future.

Conservation context

Above: The wall paintings comprise several schemes spanning the 12th to the 18th centuries, each one characterized by different original technologies, conditions and states of deterioration.

Painting conditions, deterioration processes and conservation requirements and outcomes are influenced by the following contextual factors:

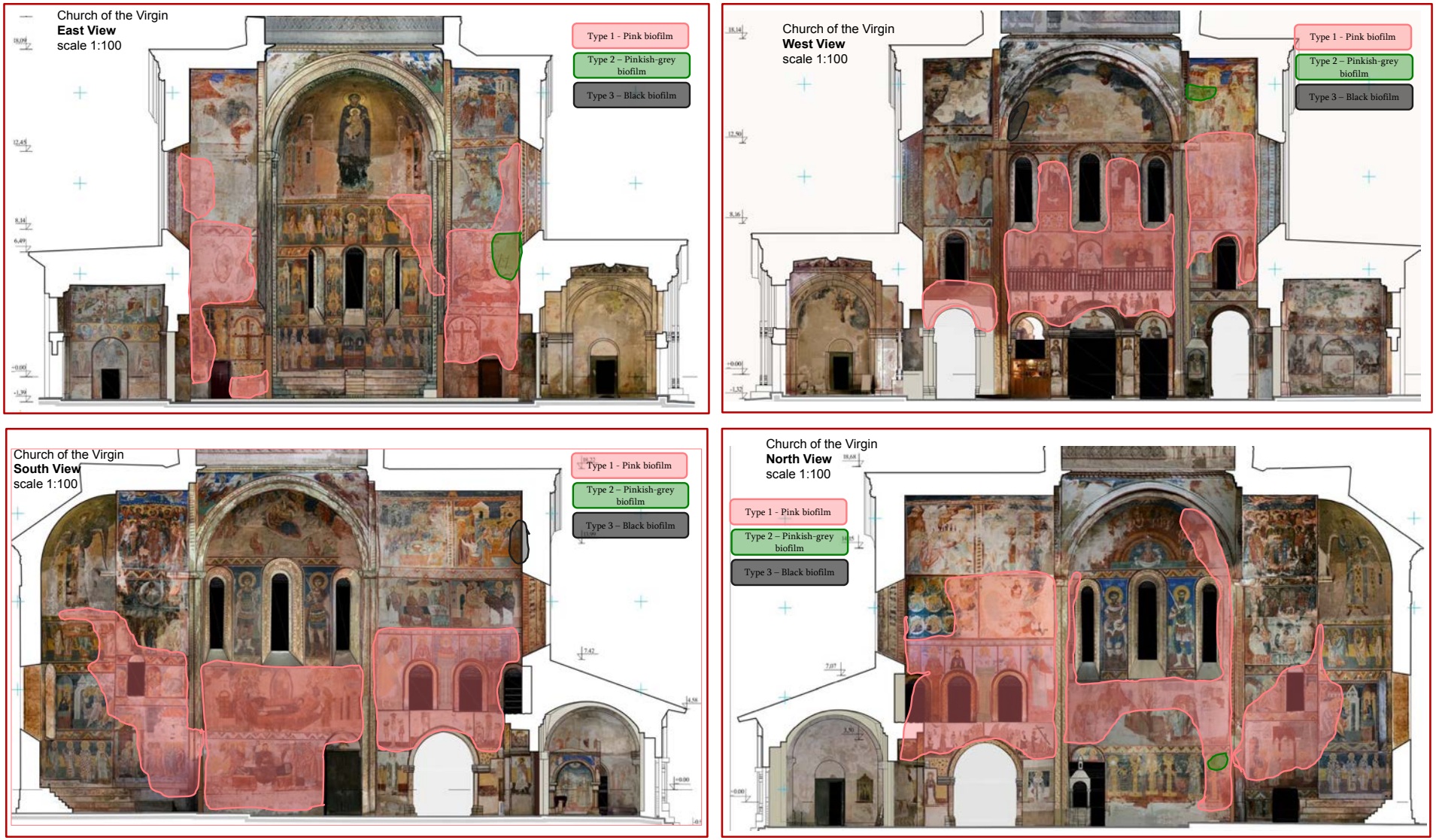
- **multiple painting schemes, technologies and conditions:** the wall paintings in the Gelati complex span the 12th to the 18th centuries. Most schemes are broadly separated by century, but some are present in multiple stages executed close in time (in the 16th century, for example, several painting phases date to the early 1520s, the 1550s and 1560s-1570s). Painting schemes variously survive as single or superimposed phases, or as adjacent additions. They are characterized by widely differing original plaster and painting technologies, and application procedures. Differences of age and technology influence aspects of condition and deterioration. Conditions of plaster failure are specifically related to the number and types of superimposed layers present, for example.

- **physical history:** the multiple schemes testify not only to a history of sequential patronage, but also to a physical history of ongoing deterioration and loss, which required partial or total replacement of paintings. Top-down deterioration primarily activated by moisture ingress has been a feature of the fabric and its paintings from their inception.

- **conservation history:** treatment of the wall paintings in the modern period began in the 1950s-60s, and subsequent interventions are recorded in most decades up to the 2020s. Remedial treatments have been carried out in all parts of the interiors. They include painting detachment and transfer, repairs to plaster losses and edges, injection grouting, re-adhesion of flaking paint, consolidation of plasters and paints, cleaning interventions, and reintegration and restoration measures. Many past treatments were not fully documented, and their nature and extent are unclear. This is especially the case for procedures now hard to identify, such as cleaning and consolidation interventions. Ongoing investigations and analysis are only now identifying the unrecognized presence of previous treatment materials.

- **inherent and long-term deterioration:** although many types of damage and deterioration are present, salt activity and biodeterioration stand out for their widespread occurrence and serious impacts. Both are inherent to the nature of the fabric and its environmental context. The physical and conservation histories attest to their long-term impacts. Salts are especially prevalent in the upper registers of painting and on the vaults, indicating the role of historic (and more recent) water infiltration in transporting them to the plaster and paint layers from sources within the fabric. Damaging cycles of salt crystallisation and deliquescence continue to be driven by unstable climate conditions. The role of biogenic colonization and deterioration is understudied but widespread, manifesting in numerous ways. Preliminary investigations indicate technique- and condition-specific colonization behaviours.

Above: The vault of the North Entrance showing effects of rainwater infiltration and transportation of damaging salts. This typifies inherent conditions in many parts of the Gelati complex

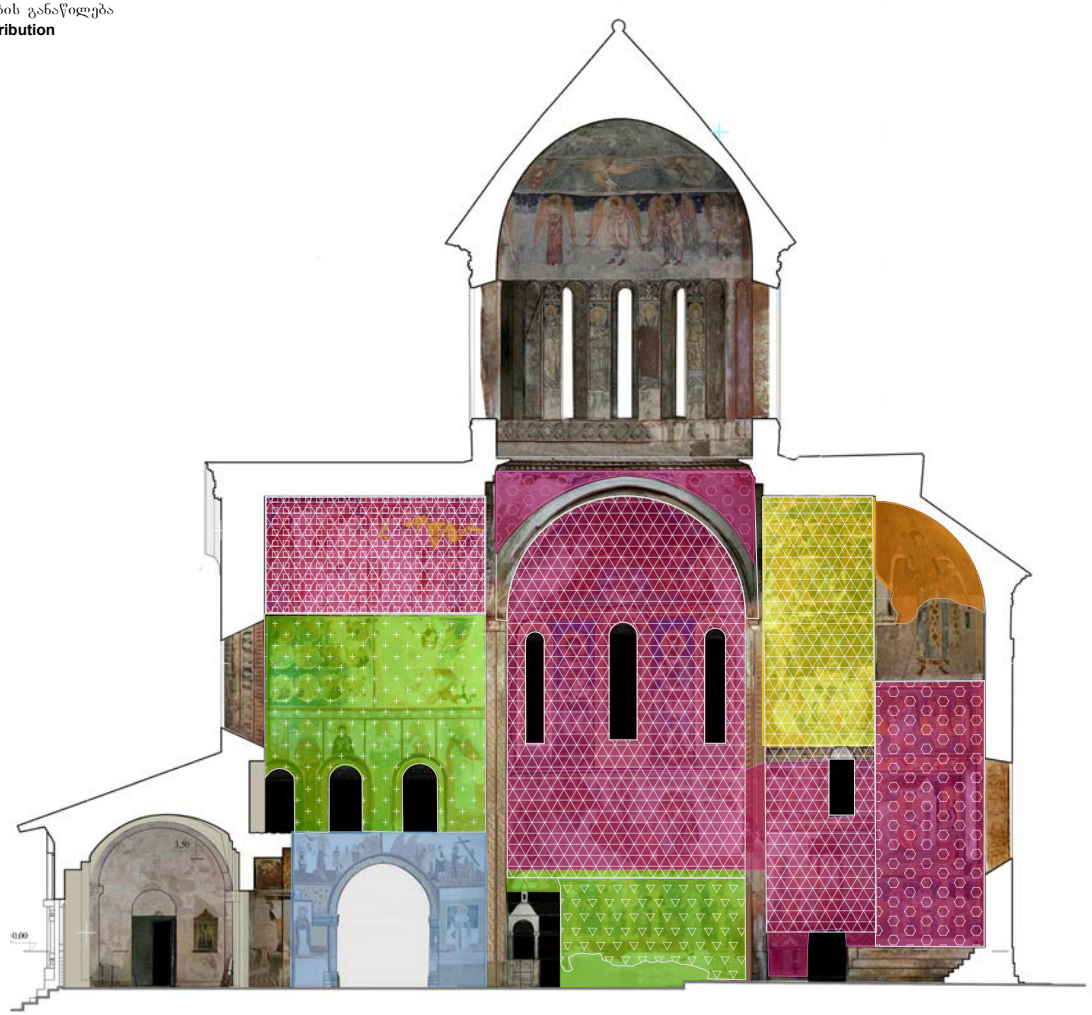


Above: Graphic documentation showing extent of different forms of biological colonization throughout the Gelati complex.

გრაფიკული დოკუმენტაცია / Graphic Documentation

კედლის მხატვრობის განაწილება
Wall Painting Distribution

ჩრდილოეთის ჭრილი
North section



ჭრილის წყარო: საქართველოს კულტურული მემკვიდრეობის დაცვის ეროვნული სააგენტო

Source of section: Georgian National Agency for Cultural Heritage Preservation

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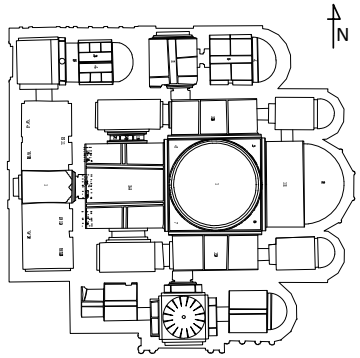
გელათის სამონასტრო კომპლექსი
ღვთისმშობლის
შობის ტაძარი

Church of the Nativity of Virgin Mary

გეგმა / Plan



მთავარი სივრცე
Main Space

ლეგენდა / LEGEND

მხატვრობის სქემა
Painting scheme

- სქემა I / XII საუკუნე — Scheme I / XII century
- სქემა II / 1520-იანი წ. — Scheme II / 1520's
- სქემა III / 1550-იანი წ. — Scheme III / 1550's
- სქემა IV / 1560-70-იანი წ. — Scheme IV / 1560-70's
- სქემა V / 1657-1660-იანი წ. — Scheme V / 1657-1660's
- სქემა VI / XVIII საუკუნე — Scheme VI / XVIII century

ნალესობის ტიპები
Plaster types

- ნალესობის ტიპი I — Plaster type I
- ნალესობის ტიპი II — Plaster type II
- ნალესობის ტიპი III — Plaster type III
- ნალესობის ტიპი IV — Plaster type IV
- ნალესობის ტიპი V — Plaster type V
- ნალესობის ტიპი VI — Plaster type VI

შედგენის თარიღი
27.12.2024

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Above: Graphic documentation of the north section of the Main Church showing the distribution of different phase of painting spanning the 12th to 18th centuries. Each of these painting phases is characterized by different original technologies which influence their current condition and states of deterioration.

Defining constraints and possibilities

The contextual conditions and circumstances indicate a range of considerations that must be recognized and accommodated in the wall painting conservation plan. **They are:**

- **inherent deterioration:** as salts deterioration and biodeterioration are endemic to the fabric, they cannot be entirely eradicated. Options for environmental control and mitigation are also limited. The presence of salt species with wide phase change parameters means that climate conditions that prevent one type of damaging salt activity may promote others. Conditions that suppress salt activity are likely to encourage biological colonisation, and *vice versa*;

- **compromised states:** very few areas of the paintings have *not* been previously treated. Added materials are widespread and their presence and degradation further complicate conditions of failure that are inherent and already severe;

- **condition complexities and variability:** while similar types of deterioration and failure occur across the wide spectrum of surviving paintings, conditions also vary widely on a micro-scale, from one square cm to the next.

These challenging conditions and the constraints they place on conservation options are not unusual for complex and large wall painting sites such as Gelati. In line with wider international practice, expectations of conservation outcomes in this context emphasise sustainable measures rather than panaceas. Focusing on remedial treatment alone or as the immediate priority will only lead to wider failure (see **images** this page). Realising and accepting this is already a major step forward and a cause for optimism, allowing the programme to move beyond the reactive, fragmented 'sticking plaster' responses of the past to a multi-disciplinary and knowledge-based approach.

The difficult and highly variable wall painting conditions mean that standardised conservation measures can rarely be employed. Specifically designed responses are mostly required, as are long timescales to determine, implement and evaluate appropriate interventions and other measures.

Above: The failure of many previous repairs indicates that a different conservation approach is now required. In the top image, collapse of the repairs has caused loss of surrounding original plaster. In the bottom image, a previous repair remains in place while the surrounding original plaster it was meant to secure is lost.

Foundations of the conservation programme

Above: Professor Dr Steffen Laue (Fachhochschule Potsdam, University of Applied Sciences) with members of the conservation team monitoring and sampling salts in the West Arm.

Effective conservation is achieved through a process of acquiring data so that informed choices are made and implemented. This evidence-based approach implies that multiple data are evaluated before major conservation measures are decided and taken. This is recognized as standard international conservation practice.

For the Gelati wall paintings there has been a substantial period of pre-treatment examination, investigation and recording. Since 2023, components have included condition recording and assessment, investigations of original technologies, environmental monitoring, salts and moisture investigations, microbiological investigations, and specific condition monitoring, environmental assessment and salts analysis. Each category is summarized on **pages 9–14**; fuller outcomes and findings are reported elsewhere in the project's documentation archive. These activities do not end with the start of remedial interventions. They become part of an ongoing process, further informing treatment planning and implementation.

Addressing the deterioration at Gelati is not straightforward due to the complex conditions, the difficulties involved in knowing which parameters to alter to make improvements, the likely unintended consequences that even beneficial outcomes can also bring about, and the time required to fully assess changes and their impacts. The only way to address these challenges is by interdisciplinary collaboration. Conservation measures must be supported by scientific understanding. It is a mark of the project's status that it has enlisted the assistance of internationally renowned conservation scientists with specific expertise of salts damage and biodeterioration of wall paintings. They are Professor Dr Steffen Laue (Fachhochschule Potsdam, University of Applied Sciences) and Dr Daniela Isola (Researcher, Tuscia University, Viterbo), respectively.

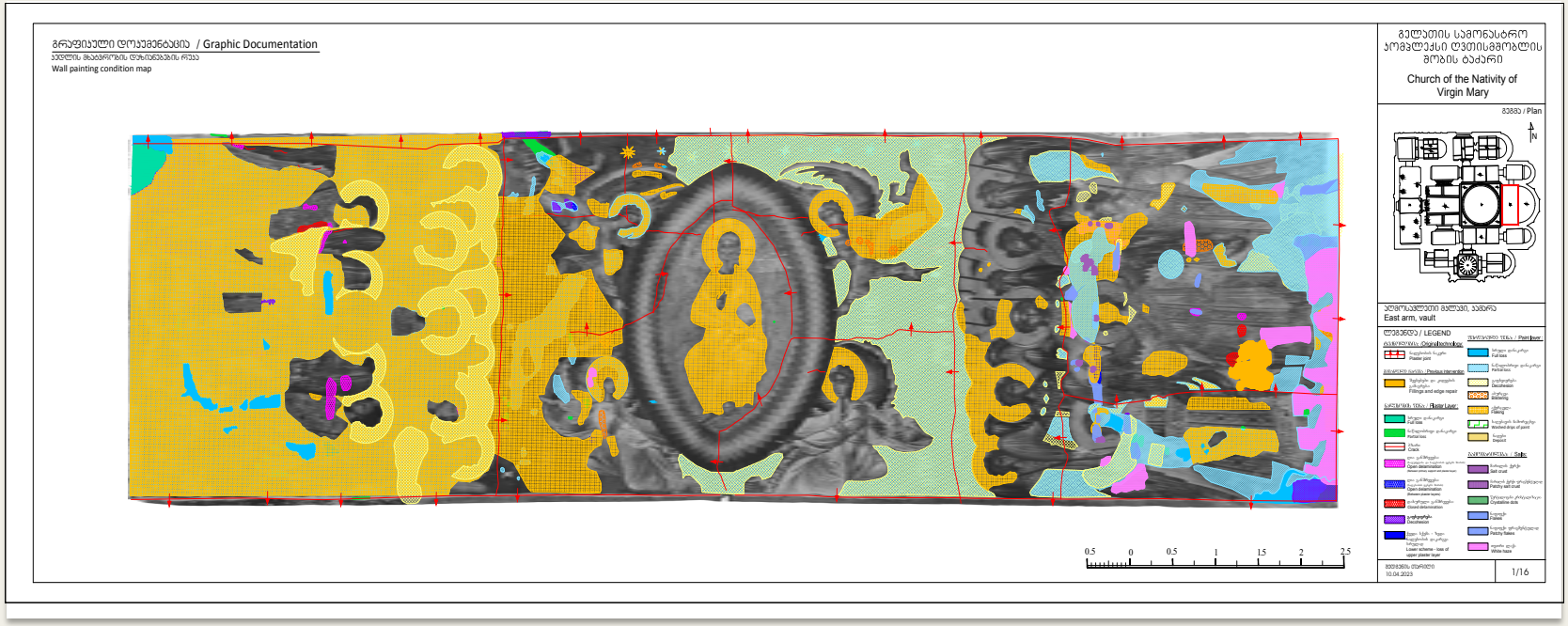
The task of preserving the wall paintings is best approached as a diagnostic undertaking, in which science-based decision-making maximises conservation efforts and their outcomes. This approach forms the foundation of the conservation plan at Gelati.

Condition recording and assessment

The wall painting team is systematically recording and assessing the condition of *all* the paintings throughout the Main Church and the peripheral chapels and entrances. The total surface area in the church complex is almost 2,500 square metres, the majority of which preserves historic plaster and painting. The condition assessment is therefore an immense undertaking, which has been ongoing since 2023 and is scheduled for completion by the end of 2025. While compiling pre-treatment condition documentation is now considered both an obligation and standard conservation practice, this is the first time in Gelati's history that such a comprehensive record has been made of its wall paintings. It is an achievement not to be underestimated.

The condition assessment has fundamental importance for placing the wall painting conservation programme on a sound basis. It provides a unique pre-treatment site record. In identifying conditions that threaten the safety of the paintings, it is an essential aid to risk assessment and prioritisation of interventions. Conversely, it is also means of determining where interventions may *not* be required.

Another crucial component of the condition assessment activities is to establish base-line data on rates of adverse change, or its absence. This has a fundamental bearing on planning the timing, nature and extent of remedial interventions.



Above: An example of the graphic documentation of conditions being carried out for all the Gelati wall paintings, providing a comprehensive record of their state of conservation.

Investigations of original technologies

The wall painting schemes differ technically from each other in significant and diverse ways, such as in the number of plaster layers present (single or multiple), the composition of the plaster types and ratios of their components, the paint materials used and their methods of application, and so on. The conservation programme provides a unique opportunity to establish and extend technical knowledge in these and other areas, which is a core obligation.

Understanding the technical complexities and differences also has important conservation implications. The material diversity means that conditions and effects of deterioration differ from scheme to scheme. The multi-layered paint stratigraphies include materials that are susceptible to alteration and inherent degradation. The potential for damaging interactions between original materials and added contaminants (eg, salts, biodeterioration, previous treatment materials, etc.) is considerable and understudied. Identifying these risks is a conservation requirement. Knowledge of inherent materials vulnerabilities is needed to inform appropriate conservation options.

Investigating the original technologies is a gradual and ongoing process. Initial methods privilege non-invasive examination and imaging, and outcomes of these will define subsequent analytical needs. Examination and investigation procedures already carried out or underway include:

- ***detailed visual observation, recording and imaging:*** **to determine fundamental aspects of the painting materials and stratigraphies, such as the nature of primary supports and their preparation; the nature and application of preparatory layers; evidence of setting out and drawing techniques; palette and pigment use/application; nature of pigments used, etc.;**

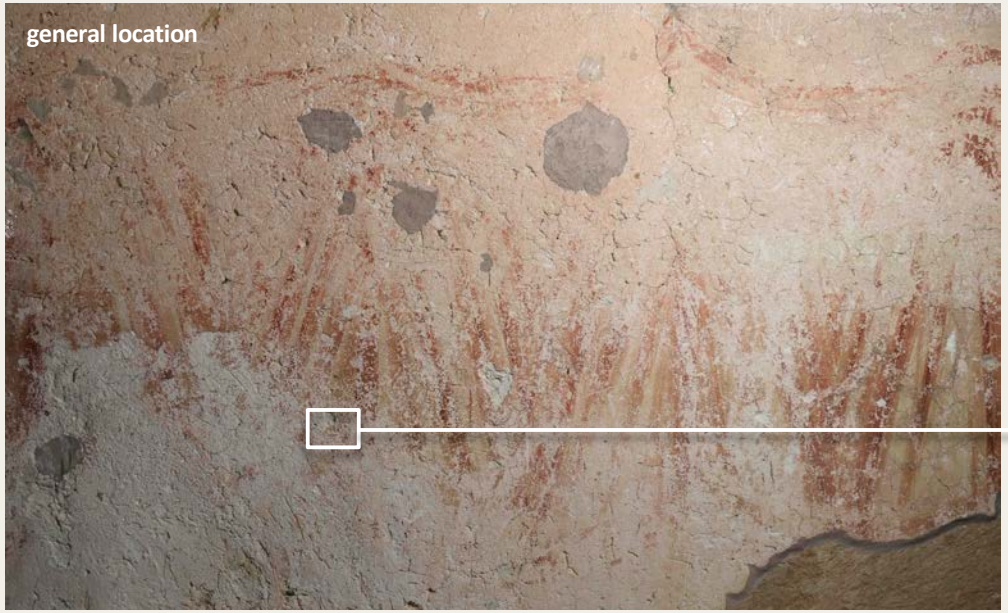
- ***in-situ digital photo-microscopy:*** **providing high-resolution images at 50–200x magnification (resolution: 1.3 megapixels). This facilitates detailed topographic and morphological examination, providing useful information on the nature of original materials (particle size, shape, heterogeneity etc.). It also allows detailed inspection of added materials and/or contaminants, and of altered materials (such as degraded pigments). Coupled with a capacity for UV examination, it can be useful for establishing the presence, and to some extent the nature of organic materials, such as colorants, binding media, and coatings;**

- ***multi-spectral imaging:*** **technical imaging for visualising materials not visible in normal light, including the presence of organic coatings, binders, and glazes, and for differentiating between original and added materials. Under UV excitation, some pigments luminesce at characteristic visible light wavelengths which allows them to be readily identified without further analysis. IR imaging can help to clarify faint or semi-legible aspects of the painting technology;**

- ***preliminary pXRF survey:*** **for non-invasive, multi-elemental characterization of pigments and paint materials;**

- ***paint analysis:*** **removal of 26 small paint samples (1-2 mm) for initial microscopic cross-section and dispersion analysis followed by scanning electron microscopy (SEM) to identify and characterize material components;**

- ***plaster thin sections:*** **for further characterization of aggregate types and ratios in the original plasters.**



Images this page: example of characterization of original plasters using in-situ digital photo-microscopy. These investigations not only extend knowledge of the nature of the original plaster materials but also help inform the formulation of new repair materials.

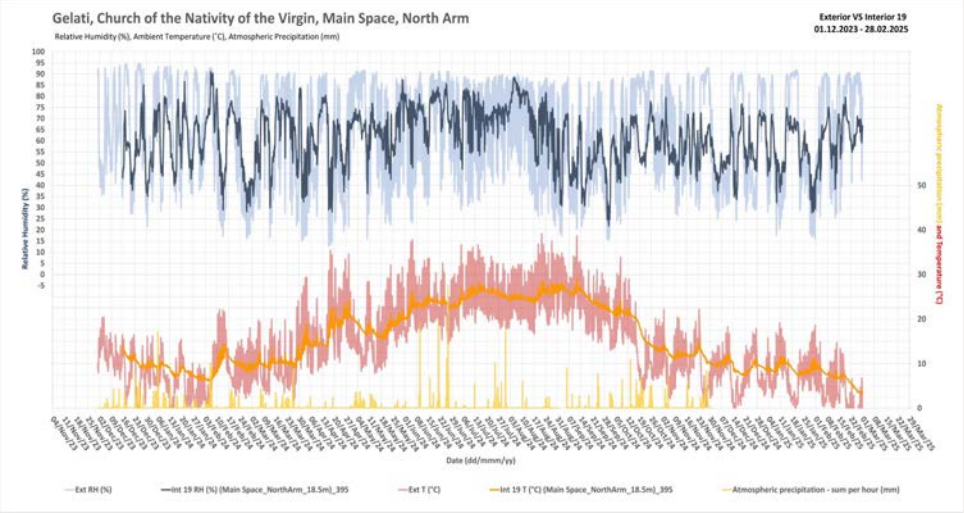
Environmental monitoring and assessment

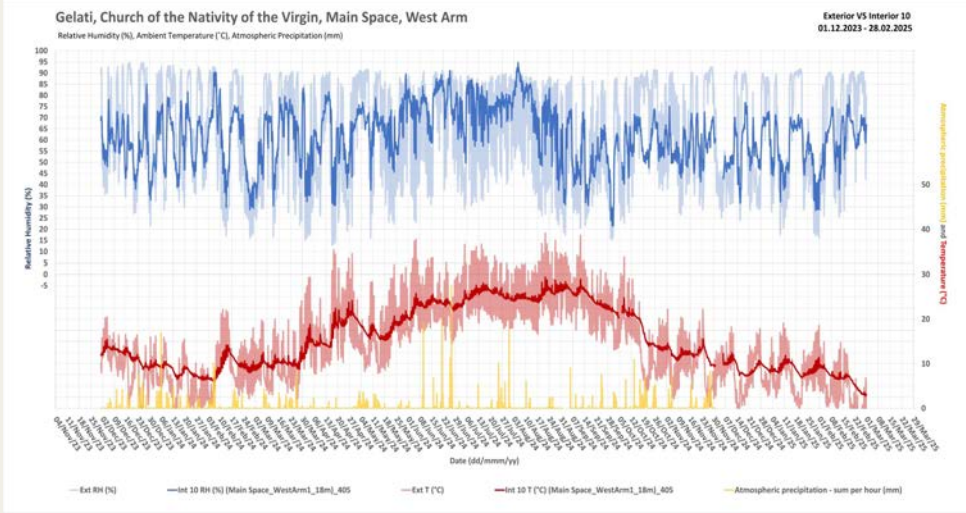
Most deterioration of the plasters and painting at Gelati is environmentally driven. In combination with condition assessment and monitoring, a programme of environmental monitoring is an essential component of the the conservation programme. While processes of environmental deterioration cannot be eliminated entirely, a principal conservation goal for preserving wall paintings in their context is to define the prevailing environmental conditions and to identify mitigation measures, as far as this is possible.

The current environmental monitoring programme at Gelati was started in 2023 and has been ongoing and expanded since then. Data loggers measure relative humidity (RH%), ambient temperature (ATºC) and surface temperature (STºC) throughout different parts of the Main Church and its associated chapels and entrances; relative humidity and ambient temperature are also collected on the exterior. Absolute humidity (AH%) is calculated. The main objective in comparing external and internal parameters is to establish the role of air exchange on the paintings.

The data show consistent patterns across all four arms of the Main Church, demonstrating that the macroclimate (and especially rainfall) is the main influence on the interior climate, although additional moistures sources (eg, evaporation of ground water) are contributory factors. The permeability of the interior to exterior influences results in unstable conditions. Relative humidity fluctuates widely on an annual, seasonal and daily basis. Although the building exhibits reasonable thermal buffering, significant fluctuations occur, especially on a seasonal basis.

Impacts on the wall paintings are serious. Environmental fluctuations continually drive salt-related deterioration. Biodeterioration, not yet fully studied, is another dominant deteriogen intimately associated with climate fluctuations.





Above: Examples of graphed environmental data collected from the North Arm and West Arm of the Main Church.

Salts and moisture investigations

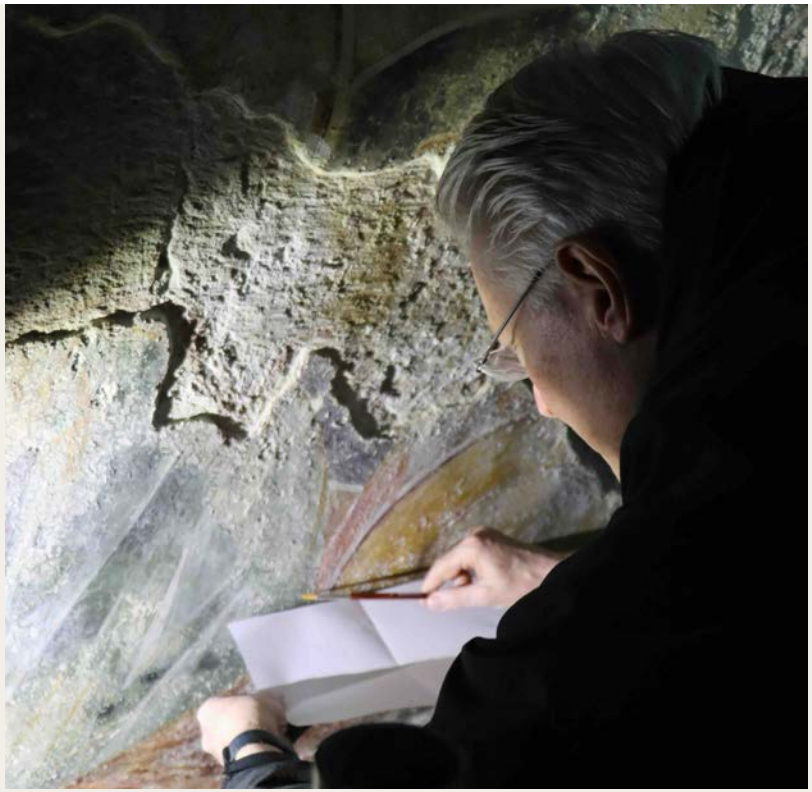
Salt-related deterioration is one of the greatest threats to the wall paintings, in its extent, complexity and severity. Conservation measures to address the salt problems can only be formulated based on specific scientific knowledge including establishing which salts are present; determining their concentration and extent (both topographically and in depth); establishing their sources; and verifying under which climate conditions they cause most harm.

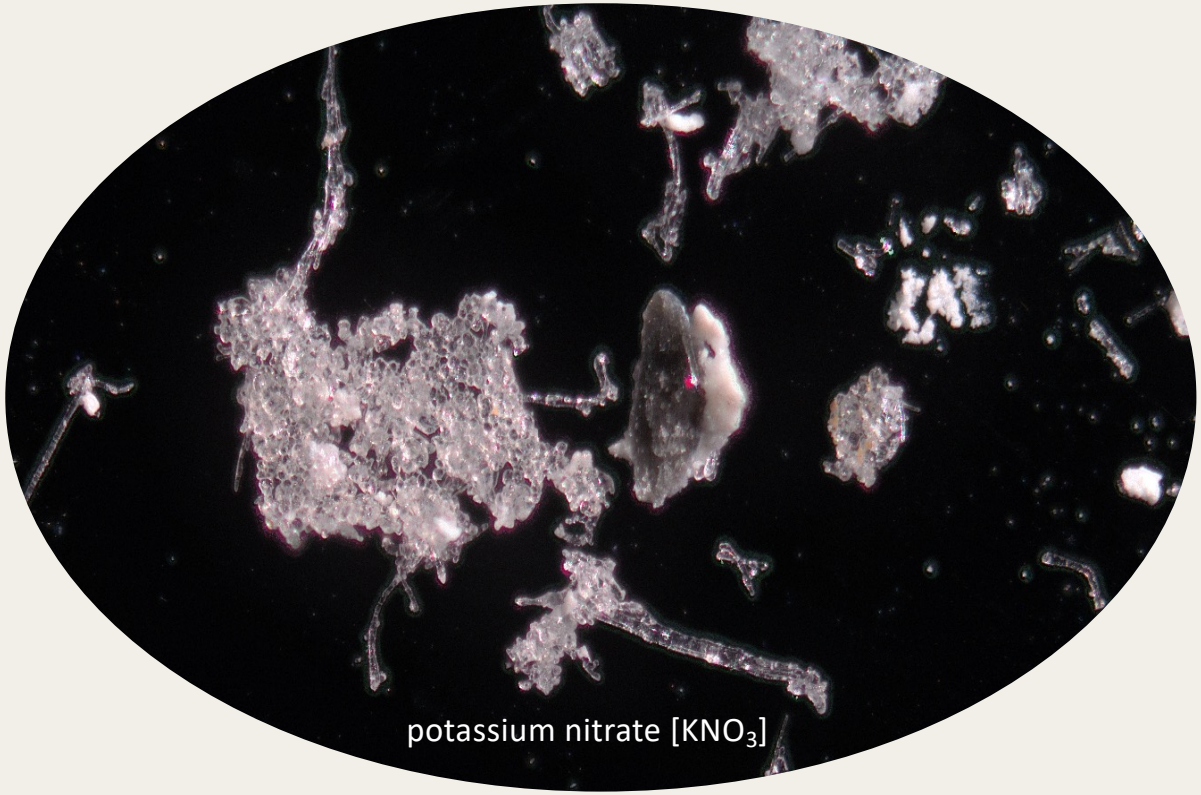
Understanding the nature and movement of salts in wall paintings is a specialist discipline. The wall painting conservation programme has enlisted the world-class expertise of Professor Dr Steffen Laue of Potsdam University of Applied Sciences to fulfil this role (top right image). Importantly, his scope of work is not limited to a single period of investigation, sampling and analysis, but is being carried out as an ongoing component of the conservation programme, so that findings can be used to inform conservation decisions on an area-by-area basis. This level of scrutiny and coordination between specific salts investigations and treatment implementation is exceptional.

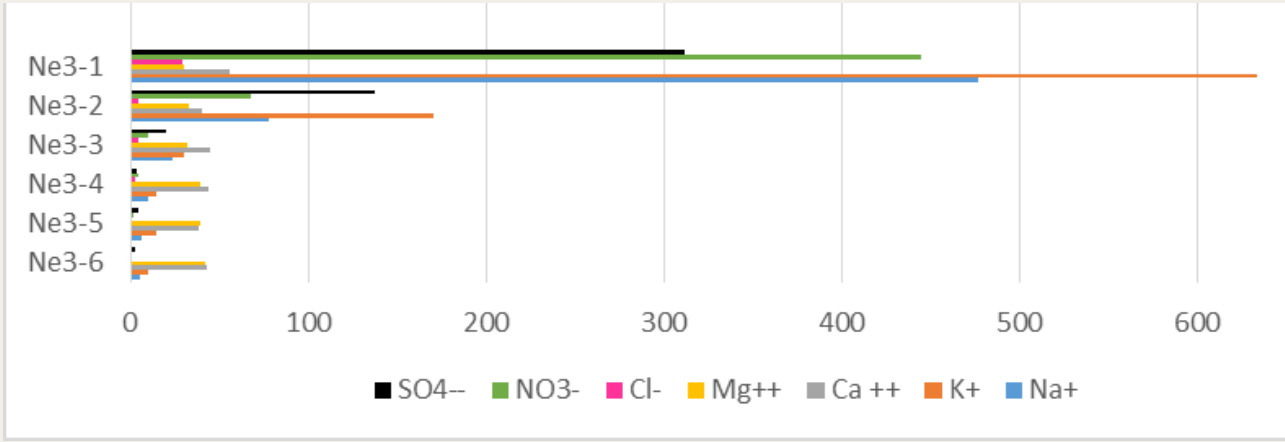
Findings have far-reaching implications for the conservation programme. 10 different salts have been detected, falling into 4 main categories: gypsum, magnesium carbonates, magnesium sulfates and potassium nitrate [KNO_3]. Some of the identified salts are very damaging and are active over a wide range of climate values. Salt sources are various and include the original materials of the church (especially the dolomitic limestone), and added contaminants and pollutants, including probably from previous conservation treatments.

Other findings are critical for enabling the conservation programme to arrive at some solutions for these difficult problems. Analysis of core samples shows that there is high salt content only in the plaster layers and not in the underlying stone. This means that there is an opportunity to undertake salt reduction measures as a remedial treatment component.

Results of moisture core samples taken in vertical profiles from the west and east walls of the North Arm in the Main Church indicate that the fabric is essentally dry in depth in these locations.





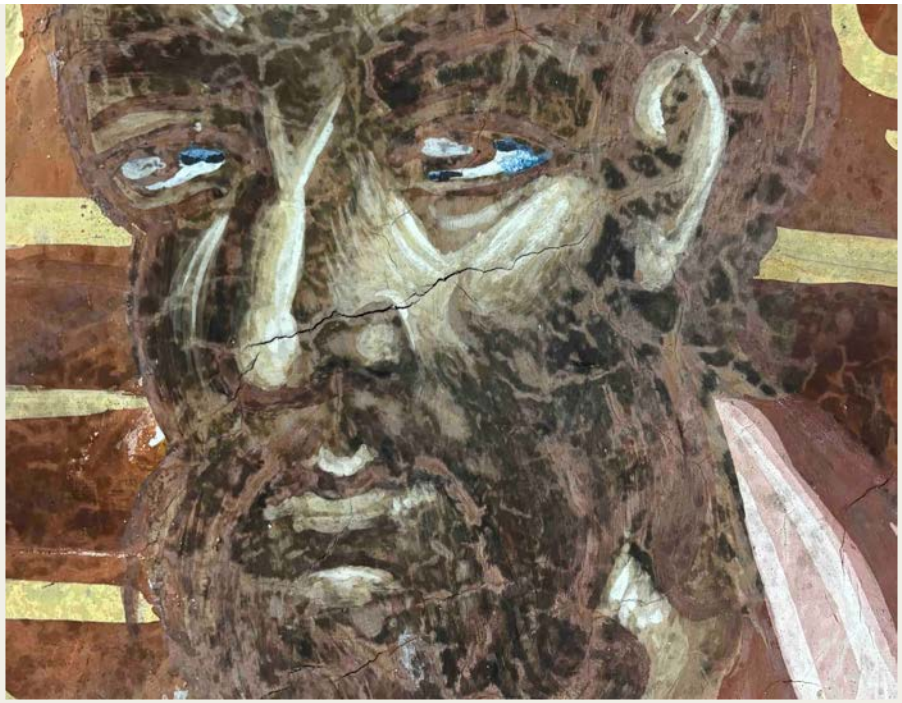


Images this page: salts are a principal cause of damage to the wall painting at Gelati (left). The main crystallizing salts have now mostly been identified. The sources of some salts, including for potassium nitrate (top), are still under consideration. Analysis of incremental core samples indicates that salt content greatly reduces with depth (bottom), indicating that salt reduction procedures can be incorporated into the treatment programme.

Microbiological investigations

Alongside salts, biological colonization is a principal deteriorgen at Gelati, affecting the wall paintings equally extensively and severely. Many interrelated factors influence or inhibit the growth of microorganisms. The study of their effects on wall paintings is only just beginning to identify the many and very serious adverse impacts they have. To understand the risks and determine control measures, specific expertise is required. The conservation progamme has engaged Dr Daniela Isola of the University of Tuscia, Viterbo, Italy, for this role.

Ongoing investigations are being carried out to determine the types of biodeterioration that are present and where, and what harm they are doing; which factors promote or limit the growth of microorganisms (eg, moisture, light pH, temperature, nutrients, nature and topography of the substrate); whether biodeterioration is dead, dormant or active; and to elucidate the ecological succession of the biological species (ie, the processes of colonization and modification that they demonstrate).



Above: microorganisms are present on the paintings in many diverse forms, such as the dark mottling seen on the figure in the top image. An example of biological colonization at a micro-level is shown in the bottom image. Impacts have not been fully explored, a task that requires specific expertise. Left: Dr Daniela Isola of the University of Tuscia, Viterbo, Italy, shown here taking a biological sample, has been engaged for this role.

Initial programme development

The remedial treatment component of the wall painting conservation programme was essentially launched as a new endeavour in March 2023. This start-up phase necessarily involved substantial planning and development before treatments could safely commence at scale. These components are also achievements that merit recognition. **They include:**

- **conservation laboratory and organization:** the successful implementation of the treatment programme depends on high professional standards in all its components. Of fundamental importance has been establishing a conservation laboratory so that proper storage, preparation and testing of materials are possible, and in-house analytical procedures may be carried out to facilitate conservation measures;

- **development and testing of remedial treatments:** at the beginning of the project, no treatments were in place to address the many and varied conditions of failure in the Gelati wall paintings. A period of development and testing of treatment materials and procedures was essential. While some standardised and already available conservation materials form the repertoire of planned and implemented treatments, the majority are individualised to specific conditions and original technologies at Gelati, and they are formulated based on an evaluation of specific performance characteristics and working properties.

Treatment approaches and criteria

The remedial treatment programme places the site's unique conditions in a context of generally accepted ethical and technical approaches. The main criteria that govern the treatment process and its implementation are summarized below:

- **conservation in existing condition:** modern principles of site conservation oblige us to preserve wall paintings *in situ* in their existing condition and focus efforts on preventing or slowing deterioration rather than attempting to return paintings to some putative former state or appearance, especially when such efforts may cause further harm;

- **conservation hierarchy:** conservation measures are selected to achieve greatest efficacy with least intervention, choosing from preventive, passive and remedial options. In this hierarchy, remedial treatments are regarded as 'least' effective. This does not mean that they are unnecessary or are not beneficial. It means recognizing that they do not provide a panacea, and to be effective must be implemented with other conservation measures;

- **compatibility and stability of treatments:** principles of compatibility and stability of materials are especially important at Gelati considering its history of failed previous interventions and the context of ongoing environmental deterioration. Compatibility/stability depends on the selection and use of treatment materials that match the behaviours of the original materials. Moreover, they should not impede the function of original materials in circumstances of ongoing deterioration;

- **minimal intervention:** as areas requiring treatment at Gelati are extensive, the principle of 'minimal' intervention is interpreted as limiting treatments to stabilization measures that address essential needs only (ie, where loss of original material is occurring or is judged to be imminent); that interventions are confined in their number and extent; that they are only implemented where they can be most effective; and that the range of newly introduced materials is kept to a minimum;

- **incremental implementation:** recognizing the difficulties of the deterioration context and the history of past treatment failures, it is necessary to implement treatments on a gradual basis, allow for assessment of results over long timeframes. Surveillance of outcomes is a component of treatment implementation, alongside possibilities to modify and adjust interventions.

Principal remedial treatments and their role

Remedial treatments for wall paintings are normally only considered feasible and safe to implement *after* activation mechanisms of deterioration are brought under control, if this is possible. There is a consensus in modern conservation practice that treatments carried out prematurely while deterioration agents remain active will be short-lived. At Gelati, previous treatment failures – including those of the quite recent past – and subsequent worsening conditions indicate the limitations of a remedial approach carried out in isolation when deterioration is inherent. It must now be recognized that the paintings cannot further tolerate new cycles of major retreatment and treatment failure.

This does not mean that there are no remedial options, or that all treatments must wait for deterioration to be controlled. As already emphasised, deterioration is *not* entirely controllable and within certain parameters specific stabilization treatments can be usefully and safely carried out according to the criteria outlined on **page 17**. Ongoing loss of original materials and conditions of imminent risk are fully recognized in the conservation plan, but they are approached as a holistic undertaking rather than as a remedial reflex.

The remedial treatment of the paintings comprises five main interventions: mechanical salt removal, consolidation and paint-flake fixing, 'micro-grouting', injection grouting and repairs, which are summarized on **pages 19–23**. Their primary aim is to stabilize damaged and vulnerable plasters and painting, either by removing principal deteriorgens (ie, mechanical salt removal) or by interventions that judiciously strengthen and secure fragile original materials at risk of loss (ie, consolidation, 'micro-grouting', injection grouting and repairs).

As already described, compatibility of materials is a key principle of treatment design and implementation, so that original materials and added repair materials behave similarly together, and that key functions – such as porosity – are not impeded (see **page 17**). The primary technology of the historic finishes is lime-based, and this directs the selection of the main treatment materials. A related requirement is to limit introduced materials, so that the full range of stabilization interventions are achieved without resorting to a wide range of new and diverse materials whose behaviours and interactions are uncertain. Treatments are also specifically considered and calibrated in relation to the prevalent salt conditions and the risks of promoting cycles of damaging salt deliquescence. Finally, avoidance of film-forming materials is a key treatment decision in a context where not inhibiting water vapour transfer between the paintings and their microclimate is a key consideration.

Mechanical salt removal

Salt contamination occurs over large expanses of painting and plaster. Much of this is present as solid veils and crusts on the paintings or is deposited at sub-surface levels within the plasters. But very large areas are also covered by superficial salt deposits. These contaminants are removed by gently brushing. While this is a relatively simple procedure, it must be done with great care, given the fragility of the deteriorated original materials. Several precautions are followed. Removal is carried out gradually, using a variety of soft nylon brushes. Only white brushes are used so that if any original colour is inadvertently removed, this can can be quickly ascertained and the process halted or adapted. Similarly, salts are brushed onto a dampened absorbent white pad so that removed materials can be checked. Use of the dampened pad also helps to 'catch' removed salts and prevent their redeposition. Ongoing surveillance of treated areas is carried out from one work campaign to the next to check for the reappearance of salts. If this occurs, removal procedures are repeated. In general, little or no recontamination has been found. The benefits of removing excess salts from the wall painting system are not to be underestimated.

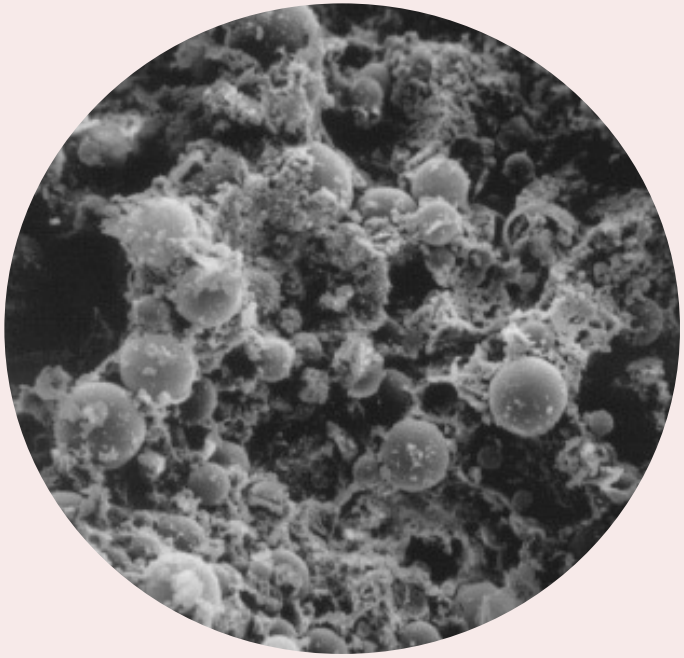
Consolidation and paint flake fixing

Nano-lime dispersed in alcohol is used for consolidation. Colloidal dispersions of $Ca(OH)_2$ nanoparticles offer a number of advantages: as a lime-based system, compatibility with the original plaster and limewash materials is maintained; proven efficacy in limiting carbonation of the nano-lime particles by CO_2 before they have been deposited in the substrate; appropriate penetration depth, strength, hardness, surface cohesion, capillary absorption, etc.; and little or no change of internal pore structures, so that effective porosity is maintained in the original materials. Nano-limes have been widely studied and verified in terms of their stability, and performance and working properties. The consolidant is used in different concentrations (eg, 5, 10 , 25 and 50 g/l) and solvent types (eg, ethanol and N-propanol) to accommodate the variable conditions that are encountered across the plasters and paintings at Gelati. Testing and usage have also established the efficacy some nano-lime formulations for relaying and securing paint flakes. This has the benefit that film-forming adhesives can be avoided.

‘Micro-grouting’

Some conditions of plaster disaggregation cannot be adequately treated with the nano-lime consolidant, and a customised ‘micro-grout’ is used instead (which is delivered as droplets from a pipette or syringe). This is formulated to consolidate/bridge larger loose particles at exposed plaster edges, for example. The ‘micro-grout’ comprises 1 part lime, 1 part chalk powder and 1 part pumice (<240 µm), + alcohol : water (1:1 v/v), the latter added to achieve desired dilution/consistency for different conditions. Dilution with alcohol is intended both to reduce risks of activating salts and to facilitate easy application.

Injection grouting



Injection grouting re-establishes adhesion between separated layers of a wall painting stratigraphy by introducing an adhesive material with bulking properties. The grout used at Gelati is based on ground-breaking research carried out at the Courtauld Institute in the late 1990s to address failures in existing grout formulations. The resulting light-weight, expansive and fast-setting grout has a 25-year successful track record. This utilises lime as the binder, as in the original plasters. The two fillers comprise fine pumice, added both to improve internal cohesion and provide a pozzolanic effect, enabling a faster rate of set; and glass microspheres, to maintain lightweight properties and promote good 'flow'. A small proportion of albumin provides additional adhesive properties, combining with the unreacted calcium hydroxide in the lime to form stable calcium albumin compounds; additionally, it functions to entrain air in the grout mixture, helping to keep its components in suspension during injection. The addition of aluminium powder produces hydrogen gas and creates expansion, useful for promoting better bonding to surfaces and countering shrinkage on drying.

As most areas of plaster separation risk collapse, temporary protection/support is provided by the application of cyclododecane (CDD), a wax-like material ($C_{12}H_{24}$). After a brief period, this sublimes from a solid to a gaseous state, leaving no residue.

Images this page: SEM image of the customized grout, showing the distribution of its filler components in the lime matrix (top right). Grouting of the 12th-century paintings in the Narthex, March 2025 (bottom left).

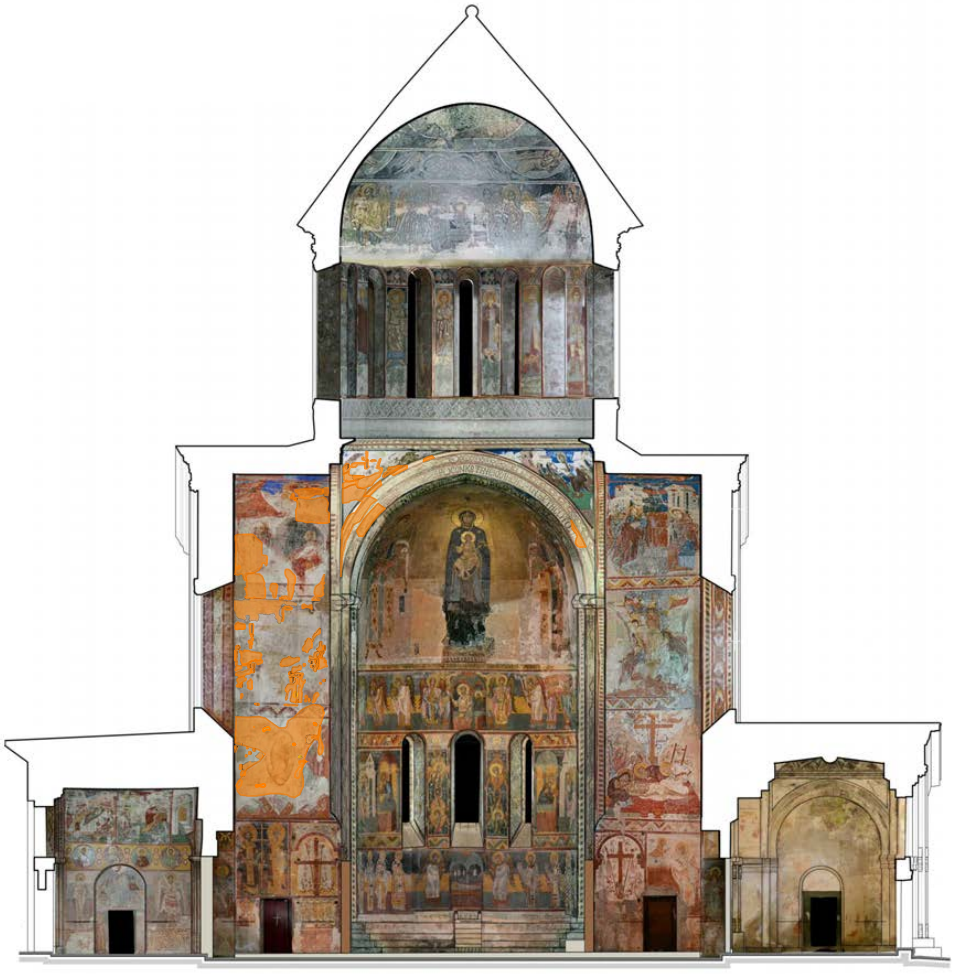
Repairs

Repairs are a simple but important measure for stabilizing original plasters in a targeted and minimal way. However, if poorly formulated and applied, they can also cause or promote harm, as has occurred in the past at Gelati. Previous repairs have been too hard, dense and brittle compared with the weaker original materials, and aggregate choices and binder ratios have been ill-matched to the original plasters they are meant to stabilize. Consequently, repairs have failed, and interfaces of deterioration have been pushed into the adjacent weaker original materials.

To be lasting and effective, new repairs must fulfil a range of criteria, (eg, stability, compatibility, appropriate strength properties, appropriate porosity, etc.). As many original plaster types are present, new repairs also have to be customized to accommodate differences of technology and condition. Using characterization of the original plasters as a starting point, repair plaster formulations are developed in the laboratory. Tests evaluate water content and release, wet and dry weights, shrinkage, and strength properties. The development rationale aims to replicate key material characteristics of the original plasters (eg, aggregate ratios, particle size) while also incorporating appropiate properties so that repairs can be applied easily and function well in their context.

Above: Many previous repairs are too strong compared with the weaker original plasters, and interfaces of deterioration and failure have been pushed into surrounding areas (left). New repairs are carefully formulated to avoid these risks, using information about the nature of the original plasters and carrying out laboratory testing to determine appropriate performance characteristics and working properties (right).

Treatment progress and prioritization



Above: Example of graphic documentation showing the east side of the Main Church and the extent of general stabilization treatments completed between 2023 and March 2025 (shaded in orange).

Conditions of serious failure are present across nearly all the wall paintings throughout the Main Church, and its associated chapels and entrances. Very large expanses of painted plaster survive in highly vulnerable condition, and it can be reasonably assumed that under the prevailing climate conditions inexorable but largely unnoticed loss of original materials is occurring in these areas. These 'majority' conditions tend to be overlooked in contrast to other – generally localised – areas of painting that exist in very critical states.

The conservation programme tackles the wall painting problems as a critical whole. As the large expanses of general deterioration present the greatest overall risks to the preservation of the paintings, they have been the primary focus of the development, refinement and implementation of the principal stabilization procedures described on **pages 18–23**. Since 2023 these treatments have been rolled out at scale, mainly – but not exclusively – in the North Arm and Pendentives of the Main Church (see **appendix 1** for full graphic documentation). Continued implementation of these and other treatments is planned for other parts of the complex, as required. A provisional **timeline** for this is shown in **appendix 2**. The spatial distribution of these projected treatments and associated activities is shown graphically **in appendix 3**.

Ongoing condition recording continues to identify new areas of risk, such as more endangering plaster separation, which has emerged as one of the most prevalent and serious threats to the paintings. Prioritization of such areas for remedial treatment is therefore a necessary component of the conservation programme. Alongside areas of **plaster separation,** specific areas and zones of **salt contamination** are also recognized as critical. Some of these areas have been further compromised and undermined by recent treatments, such as in the West Arm of the Main Church.

The conservation programme is systematically addressing these critical concerns and areas, as explained on **pages 25–33** and as also shown in the **timeline** (**appendix 2**).

Critical areas of salt contamination:

Stage 1: condition monitoring, environmental assessment and salts analysis

There are numerous critical areas of combined powdering plaster and flaking paint, found mainly in the North and West Arms. They are heavily salt contaminated and, in some cases, additionally compromised by recent treatments, as for example across zones of painting in the West Arm (image this page). Materials recorded as having been applied here include acrylic emulsions and resins, cellulose fixatives, di-ammonium phosphate and ammonium oxalate. Other materials may also be present. Some of the materials may be potentially salts-forming. Treatments were applied one over the other in some cases. The exact locations and extent of the treatments are not fully known. While all the critical areas exist in highly deteriorated and vulnerable states, it should be emphasised that monitoring shows that little or no loss has occurred in the time-frame of the conservation programme.

Liquid water infiltration was recently the principal means of transporting and activating salts in the West Arm but monitoring shows that risks of ongoing deterioration are now mainly associated with unstable microclimate conditions. Under these circumstances, cycles of damaging salt hydration and crystallization are likely to be more frequent than the 'one-off' occurrences associated with liquid water. In this context, retreatment carries high risks of exacerbating harm and causing other unintended consequences.

This does not mean that remedial treatment is not possible. The approach embedded in the conservation programme is to weigh up risks, take on board expert advice on salt activity, and collect sufficient analytical and other data to make informed decisions on the nature, type and timing of treatments.

The areas in critical condition have been the focus of specific monitoring to assess conditions in relation to seasonal climate parameters. This provides crucial information on rates of salt recurrence. Significant reductions in levels of new salt crystallization have been observed in many areas, and no recurrence in some. Core sampling in the critical areas to identify salt species and their distribution indicates high salt levels in and on the surface of the plasters, and sharp decreases thereafter in the stone fabric. Although many of the identified salts are damaging, they are also broadly soluble (see pages 13–14). Importantly, these analytical findings provide the necessary information to indicate that aqueous extraction of salts is a viable treatment.

Arriving at this state of knowledge has involved lengthy time-frames and specific scientific collaboration and expertise. This has been a necessary process to define appropriate treatment options and their parameters.

Above: A critical area in the West Arm of the Main Church.

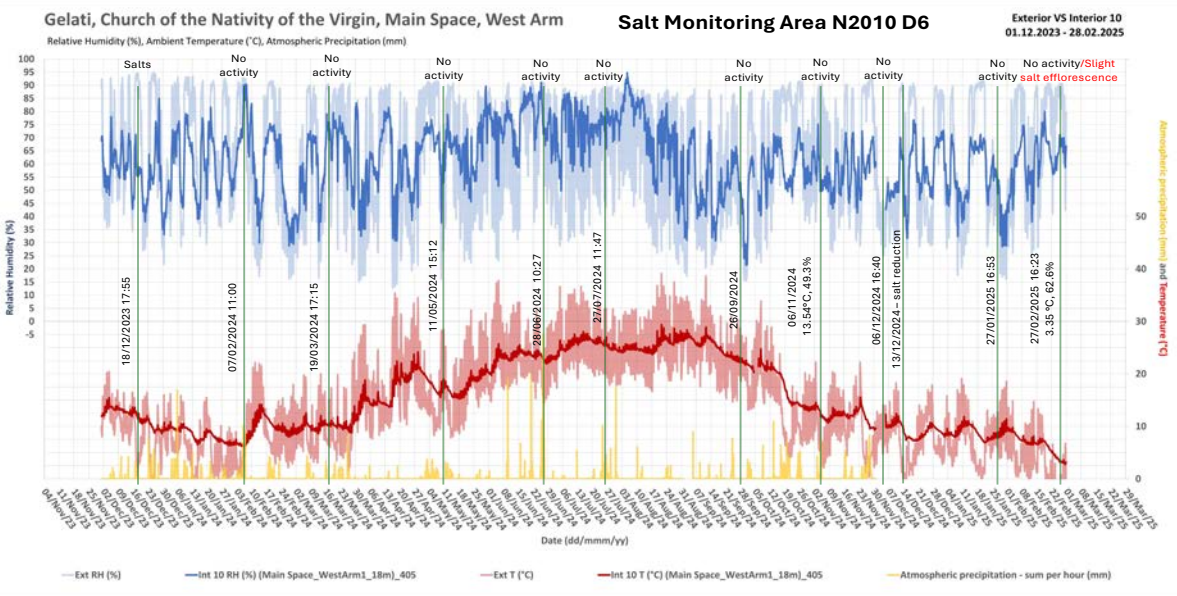
Incident light

Raking light

Date:	T °C:	RH %:
19/03/2024	10.47 °C	78.95%

Date:	T °C:	RH %:
11/05/2024	18.32 °C	58.69%

Date:	T °C:	RH %:
28/06/2024	22.35 °C	79.91%



For critical areas of severe plaster powdering and paint flaking, which are also heavily salt contaminated, and, in some cases, additionally compromised by recent treatment materials, specific monitoring is combined and correlated with collected environmental data. This establishes information on condition changes and rates of salt reoccurrence. Salts analysis targeted on these areas has identified contamination on the surface and sub-surface, identifying the viability of salt reduction treatments. The correlation of climate and condition data may also help to identify optimal seasonal periods for undertaking treatments safely and efficiently.

Critical areas of salt contamination:

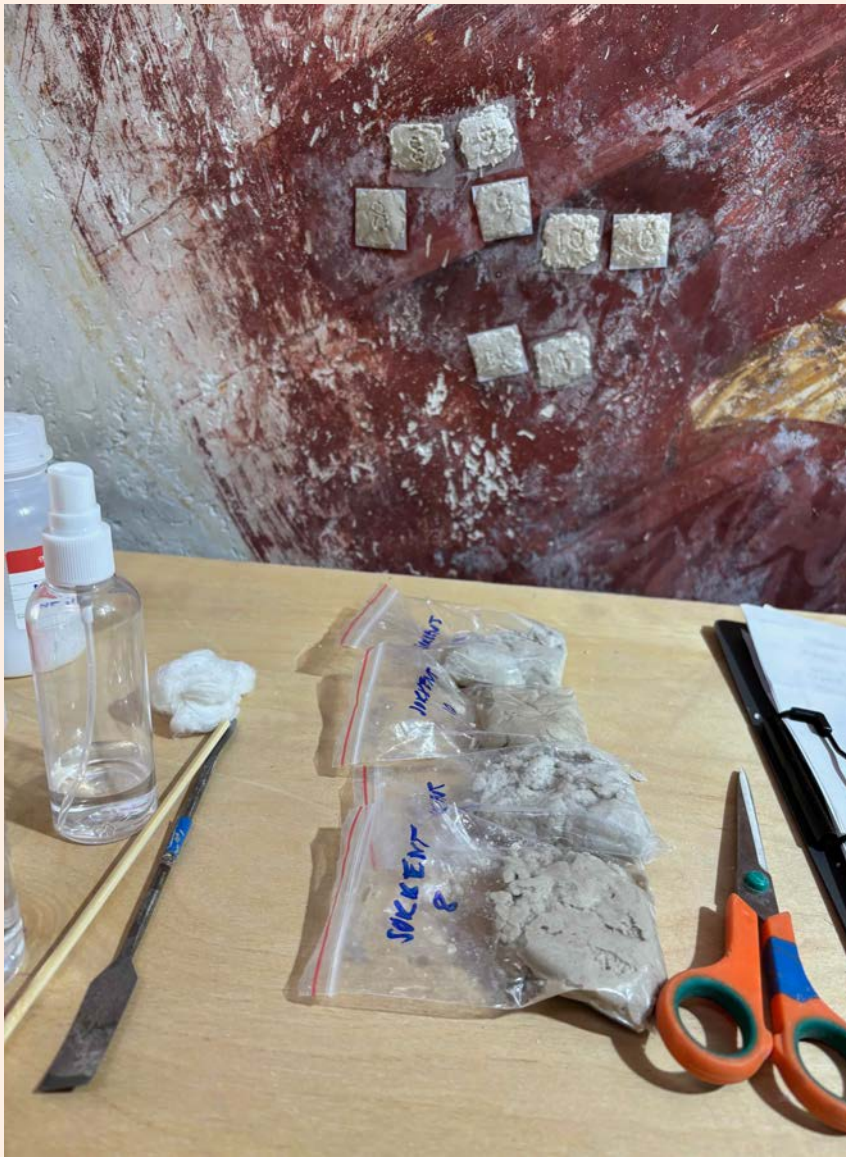
Stage 2: development, testing and implementation of salt reduction procedures

With the essential information and data acquired in stage 1 (pages 25–26), the conservation programme has moved into the development and testing of salt reduction procedures for areas of critical salt contamination. This began in July–August 2024 (page 28) and continued in March 2025 (page 29). The aqueous extraction of salts from porous materials also has broader application for other conditions and situations, such as the reduction of hard salt veils and crusts that are present on large expanses of painting throughout the Gelati complex. In addition to removing salts permanently from the system, and thereby reducing risks of their resolubilization and redeposition, a significant additional benefit would be to improve the legibility and appreciation of these obscured areas. A further application which was instigated in March 2025 is the extraction of salts during and after injection grouting (page 32). Given the scale of injection grouting that has now been identified as being required at Gelati (page 33), the development of safe and effective salt capture procedures alongside grouting is a critical treatment requirement.

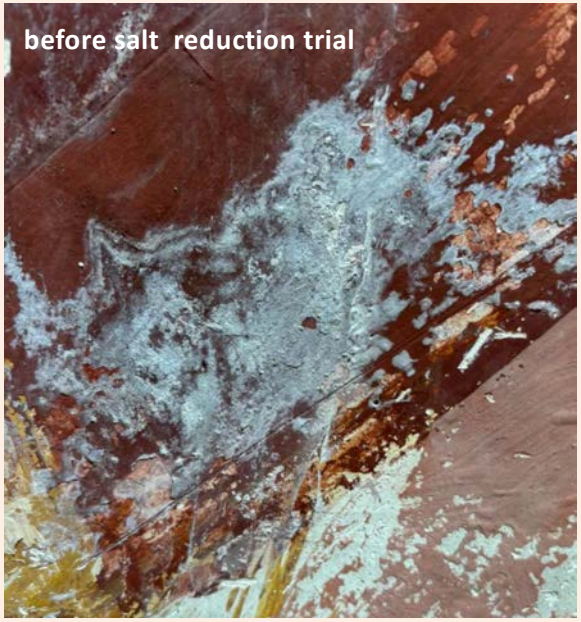
The aqueous extraction of salts from wall paintings into sorbent poultice materials is a non-reversible treatment. It therefore must be considered, planned and implemented carefully in full knowledge of both potential beneficial and adverse effects. Adequate knowledge of the salts present in the wall painting and their spatial distribution is required. Knowledge of the efficacy and performance of sorbent materials and formulated poultices is a corollary requirement. Despite significant advances, uncertainties remain on the outcomes of the intervention.

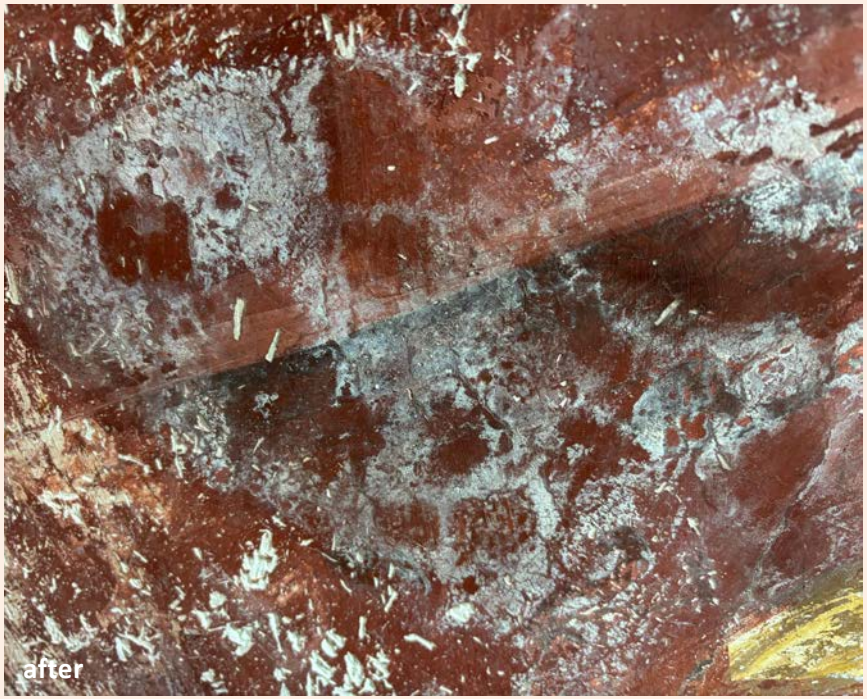
Laboratory testing of sorbents and poultice formulations and in-situ trials are ongoing. As quantitative salt analyses have shown how heterogeneously the wall paintings are contaminated with salt ions, the treatment plan will incorporate analysis before, during and after implementation. This will assess salt content both in the wall painting stratigraphies and in removed poultice materials. The integration of salts expertise (provided by Professor Dr Steffen Laue) with the treatment plan is crucial. Implementation will start in July 2025 and continue thereafter.

Right: Main Church, North Arm, East wall: in-situ testing of poultice formulations for salt reduction, March 2025.



Main Church, North Arm, West Wall: this area of painting is critically undermined by salt contamination, which has resulted in extensive disruption. The severity of the conditions places it outside the normal scope of the main treatment procedures. In July 2024 trials were begun to combine stabilization treatments (ie, consolidation, 'micro-grouting') with salt reduction. Working through a lens tissue intervention layer, disrupted painting is pressed over with a dampened sorbent pad. This both relays the raised flakes and removes excess salts, which analysis shows are present mainly at the surface. The treated lower half (below the dashed orange line) was reevaluated in March 2025 and new salt crystallization is minimal and confined to very small parts. Based on these results, treatment will be cautiously continued in July 2025 in this and similar critical areas (including in the West Arm), is association with long-tern surveillance of results and targeted salts analysis.





Top Left: Testing and formulation of sorbent poultices in the laboratory, March 2025.

Top Right: Example of before and after salt reduction trials on thick salt crusts in the North Arm.

Bottom: Multiple salt reduction trials testing different poultice formulations before, during and after application, North Arm.

Critical areas of plaster separation

As already mentioned on page 24, destabilizing plaster separation is a widespread problem which critically undermines areas and zones of painting in nearly all the schemes throughout the Gelati complex. Plaster separation is one of the greatest threats to wall paintings because collapse can be sudden and resulting loss is potentially large-scale.

Injection grouting is being systematically carried out to address the problem (see page 22). A substantial number of critical areas have already been treated, including the very important 12th-century painting on the vault of the Narthex, nearly all of which was stabilized in March 2025 (page 31). Since areas of risk are numerous and dispersed, and some have only recently been identified by the ongoing condition assessment process, they cannot be treated all at once. Prioritization incudes an assessment of the following risk factors:

- **importance and painting survival:** ***these factors unavoidably influence sequencing decisions. For example, the importance and value of the 12th century Narthex scheme made this a candidate for immediate treatment following the discovery of many critical areas of separation in February 2025;***

- **nature of separation:** ***including considerations of the location, size and state of deformation of the plaster separation. For example, large areas of plaster separation on vaults may be judged at greater risk than smaller areas on wall surfaces, due to added effects of gravity and higher risks of collapse;***

- **presence of other destabilizing conditions:** ***the presence of conditions such as interconnected cracking in the plaster which might increase risks of collapse are taken into account for sequencing injection grouting;***

- **presence of inhibiting conditions:** ***conditions that might inhibit grouting and introduce overwhelming additional risks – such as the presence of salts – may mean that grouting interventions are delayed until a wider set of precautions and measures are determined.***

Emergency and temporary stabilization measures are also implemented where necessary. These include facings, use of temporary presses, and in one case, detachment and transfer. Emergency and temporary stabilization measures will continue to be utilised where appropriate. As the process of condition assessment is now almost complete, an overview of areas of critical plaster separation is possible, allowing a prioritized plan of action to be made. This is shown in the table on pages 32–33.

Right: Injection grouting of separated plaster in the 12th century scheme in the Narthex, March 2025 (top). Facings applied to temporarily secure plaster separation on the vault of the South Arm (bottom).

The condition assessment of the 12th century painting in the Narthex, only completed in February 2025, identified extensive areas of critical plaster separation (top left). Over a 3-week period in the following month, an intensive campaign of injection grouting was launched to tackle the problem (top right). Approximately 12 litres of grout was injected and in total about 4.5 square metres of separated plaster was resecured. In a new initiative, grouting was combined with salt reduction. Absorbent presses were prepared on site (bottom left) and placed over individual grout areas with tensioned presses (bottom middle). Sorbent layers in the presses were changed daily (bottom right) and salts analysis carried out of both the grouted plasters and the removed absorbent materials to check on the efficacy of the salt reduction procedures.

Itemization and prioritization of critical areas

AREAS IDENTIFIED AS REQUIRING GROUTING		PREVIOUS RISK DESIGNATION	CURRENT RISK DESIGNATION	CURRENT STATUS	TREATMENT TIMELINE
location	**description**	urgent moderate no risk	urgent moderate no risk	awaiting grouting temporarily secured already grouted detached	2023 2024 2025 2026
n e chapel dado	small area of bulging, affected by ground water and soluble salts and because of its position a risk from physical damage. Treated as part ofinitial phase of grouting testing				
n arm e wall	treatment of various small areas of bulging, decoherent and salt-laden plaster in moderate condition begun as trial areas for team training				
narthex vault e side	severe delamination in an area of recent rainwater infiltration & salts activity above central doorway				
s w chapel s wall upper (Marina chapel)	treatment begun in area of cracking and delaminating painting resulting from recent infiltration damage				
s arm s door tympanum	bust of Christ, 'Man of Sorrows': severely detached, with pronounced distortion and bulging				
n w pendentive	largely untreatable area, extremely badly affected by rainwater infiltration, severe salts activity, bulging and plaster decohesion. Peripheral areas were saved				
s arm vault	Baptism scene: extensive area of plaster delamination where stone vaulting has dropped				
w arm w wall niche	area badly affected by past rainwater infiltration from windows above. Paint layer partially washed away, plaster lacking cohesion, highly salts contaminated and almost entirely delaminating				
narthex vault n end	12 separate areas on the west side of the vault preserving high quality C12th painting; 5 separate areas on the e side of the vault				

AREAS IDENTIFIED AS REQUIRING GROUTING		PREVIOUS RISK DESIGNATION	CURRENT RISK DESIGNATION	CURRENT STATUS	TREATMENT TIMELINE
location	**description**	urgent moderate no risk	urgent moderate no risk	awaiting grouting temporarily secured already grouted detached	2023 2024 2025 2026
pendentives (various locations)	multiple small areas of salts damage, plaster decohesion & bulging				
pendentives (various locations)	grouting will be completed on the pendentives between campaigns by the conservation team				
n arm e wall	treatment of various small areas of bulging, decoherent and salt-laden plaster will be completed between campaigns by the conservation team				
s e chapel (Narini Chapel)	severe delamination of large areas of plaster on the s and w walls, associated with cracking and salts				
n arm e wall upper	Raising of Lazarus scene: moderate sized area of buckling, highly distorted and delaminating plaster associated with the historic insertion of a metal fixture. Treatment complicated by other conditions including high levels of salts efflorescences and associated deterioration				
s w chapel s wall upper (Marina chapel)	remaining areas of painting damaged as a result of infiltration to be treated				
w arm s wall lower	small/moderate area of bulging plaster in important area of figurative painting on the lower wall and therefore accessible. Risk of accidental damage reduced by installation of temporary protection				
s arm vault	Baptism scene: grouting of temporarily secured plaster delamination				

Long-term plans and projections

This document has described the foundation, development and implementation of the wall painting conservation programme between 2023–2025 and summarizes the many activities that have been carried out in this period. The focus in this phase has been on establishing a sound basis of collected data for the project (condition assessment, investigations of original technologies, environmental monitoring, specialist investigations of salts and microbiology, etc); developing and implementing essential stabilization treatments; and prioritizing and addressing critical areas systematically.

Specialist salt investigations are now embedded as in integral component of the programme. Given the prevalent salt conditions and the risks of promoting cycles of damaging salt deliquescence by uninformed interventions, salt sampling and analysis are a key determinant of the feasibility and safety of treatments. As salt reduction procedures are developed and implemented, this exemplary interdisciplinary approach will become ever more important. While microbiological studies are still at a preliminary stage, it can be anticipated that this area of expertise will also become equally important as a means of directing appropriate conservation measures.

Other plans and projections for the conservation programme are various. Some involve embedding and extending existing activities. To improve monitoring capabilities, 3-D photogrammetric imaging will be trialled in June 2025, with the intention that this can be more widely used to gain a better understanding of the dynamics of salts crystallization, paint flaking and microbial activity. Much further work is planned on examining and analysing the paint technologies. An improvement of the laboratory facilities is planned to enhance in-house analytical capacity to accompany and inform key treatments, especially salt reduction procedures and their impacts (see **page 36**).

The principal interventions (**pages 18–23**) and treatment of critical areas (**pages 24–33**) will continue to form the core components of the remedial programme; as mentioned above, salt reduction procedures will take on an increasingly important role, too. Similarly, the reduction of damaging previous treatments, especially film-forming consolidants and fixatives, will be an important corollary treatment for salt-damaged areas. Treatment projections are summarized in the **timeline** (**appendix 2**) and their extent and distribution are shown in graphically in **appendix 3**.

Above: previous materials applied to the paintings include damaging film-forming consolidants and fixatives. From an oblique angle, some are visible as shiny surface residues (left). Elsewhere they have degraded and darkened (right). However, as records of their use are generally lacking, their extent and nature often remain unknown. Analytical investigations are beginning to identify some materials and this process is ongoing.

*Above and Right: Looking beyond the primary task of stabilizing the paintings, a range of other issues mainly to do with their poor appearance and presentation need to be considered. Some paintings are disfigured by very poor previous repairs (above). Graffiti is a significant problem for paintings at floor level (right). Provisional treatment plans and projections for these and other outstanding issues are presented for deliberation in **appendices 2** and **3**.*

Looking ahead, a wide range of other activities and potential treatments need to be considered, which are also summarized and shown in **appendices 2** and **3**. These are mainly concerned with aspects of general cleaning and presentation. Some painting in otherwise generally good condition is obscured by superficial dirt. Painting at floor level is sometimes much damaged by graffiti. An array of disturbing repairs and repainting is present. These and other issues have not so far been incorporated into the conservation programme as they do not represent urgent threats. The extent to which they should be included in future endeavours remains to be fully discussed and agreed. They are presented in the appendices provisionally for the purposes of giving broad indications of time projections as an aid to decision-making.

Finally, it is worthwhile returning to the long physical history and inherited conditions that frame and influence the wall painting conservation programme, as outlined in the overview (**page 1**). The endeavours described in this document aim to ameliorate a range of interacting and sometimes contradictory factors. It is necessary to take a broad view of what these factors are and where conservation measures stand in relation to them. Underpinning the conservation approach is recognition that challenges are predominantly inherent, relating to the climate, the natural environment, building configuration, and the materials composing the structure and the paintings themselves. A holistic overview of these conservation issues and the available options for addressing them is presented in **appendix 4**.

Team capacity building

A fundamental prerequisite and long-term commitment of the wall painting conservation programme is that it is carried out by a team of Georgian conservators, who through involvement with the project become familiarised with current approaches and methodologies and are eventually empowered to take forward the programme independently. Given the country's rich wall painting heritage, wider aims are to improve and sustain the future of conservation practice in Georgia more generally.

Currently, the programme has a team of 8–9 Georgian conservators who work at Gelati normally for about two weeks in every month. For three times a year they are joined by UK conservators Lisa Shekede and Stephen Rickerby for intensive campaigns of 2–3 weeks' duration. These periods typically also incorporate teaching, instruction and on-site investigations coordinated by the project's international experts on salts and microbiology. The conservation of the Gelati wall paintings is not a routine undertaking, but one requiring knowledge, judgement and critical awareness, as well as a very high level of practical skills on the part of each and every conservation team-member. The highest outcomes are required of the team's professional standards as well as of the treatment of the wall paintings.

In time the conservation team will become fluent in the skills necessary to tackle the complex wall painting problems at Gelati and address the full range of conservation issues in periods when the UK supervisors are not present. For example, as plaster separation is such a critical problem in so many areas (see pages 32–33), it is imperative that the team grows in its ability to take on this task. Building team capacity so that areas of high-risk plaster separation can be treated on an ongoing basis is being prioritized in the conservation plan.

While it is common practice to send samples away for analysis by technicians unfamiliar with the site and its problems, it is far more efficient and productive for analytical strategies to be developed through in-situ communication between scientists and conservators. Interaction on site with salts and microbiology experts, Professor Dr Steffen Laue and Dr Daniela Isola, demonstrates the usefulness of this approach. There is now a plan to improve existing site analytical facilities to allow further integration between analysis and treatment research and development, in the longer term by team-members trained in appropriate analytical procedures. This will be an exceptionally important advance in conservation practice.

Right: Seminar sessions given by Professor Dr Steffen Laue (top) and Dr Daniela Isola (bottom) to the conservation team in March 2025. Building the team's knowledge-base as well as their practical conservation skills and critical judgement are fundamental components of the conservation programme.

Appendices

1. Completed areas of remedial treatment 2023–March 2025

2. Conservation programme timeline 2023–2030

4. Graphic documentation of conservation programme 2023–2030

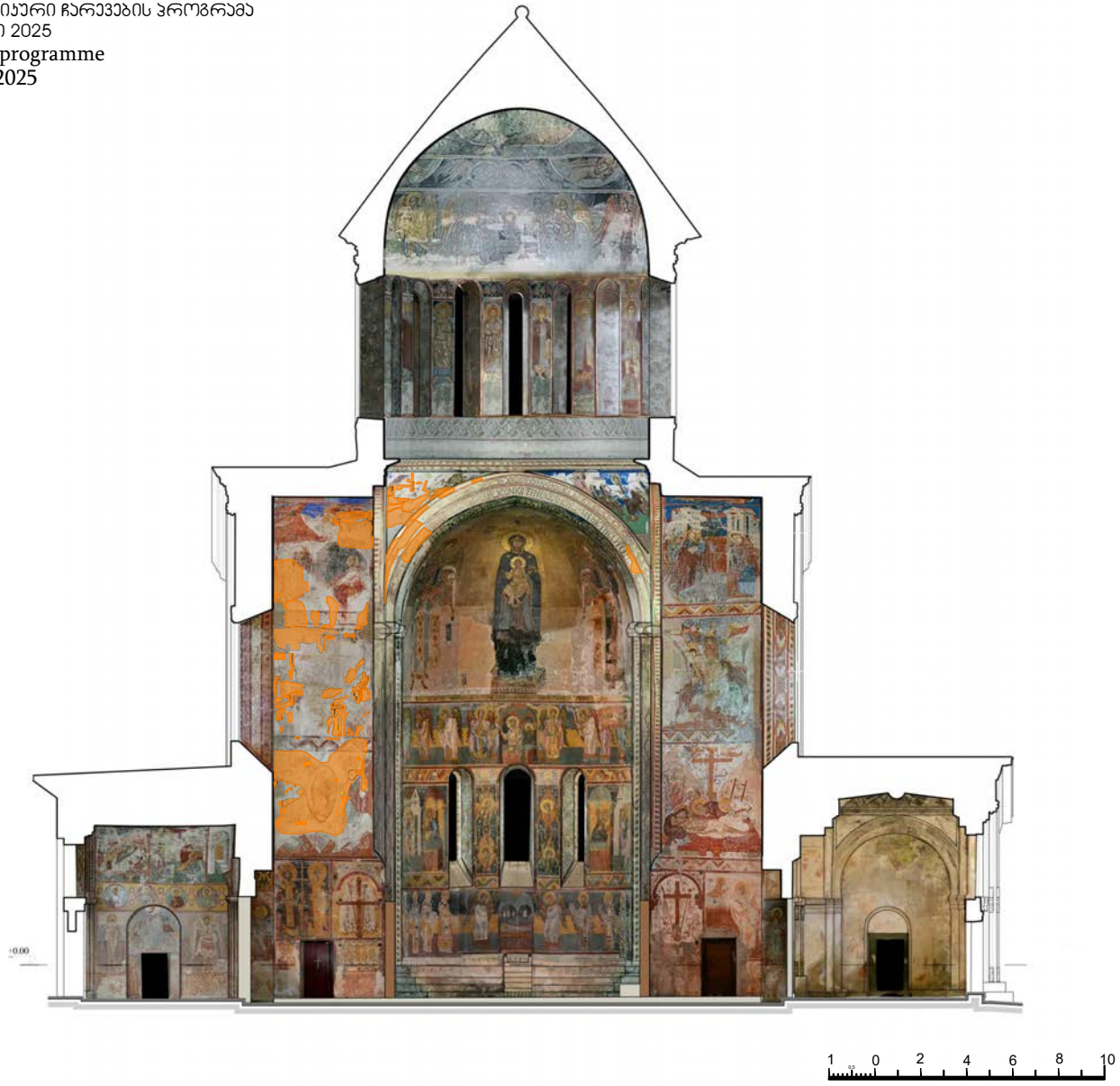
3. Holistic overview of conservation issues and options

Appendix 1:
Completed areas of remedial treatment 2023–March 2025

გრაფიკული დოკუმენტაცია / Graphic Documentation

საკონსერვაციო ფიზიკური ჩარევების პროგრამა
მარტი 2024 - აპრილი 2025
Remedial treatment programme
March 2024 - April 2025

აღმოსავლეთის ჭრილი
East section



გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

ლეგენდა / LEGEND

- Grouting
  ჩასხმა (ინექტირება)
- General stabilisation
  ზოგადი გამაგრებები

შედგენის თარიღი 10.05.2024	1/4

გრაფიკული დოკუმენტაცია / Graphic Documentation

საკონსერვაციო ფიზიკური ჩარევების პროგრამა
მარტი 2024 - აპრილი 2025
Remedial treatment programme
March 2024 - April 2025

სამხრეთის ჭრილი
South section

გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

ლეგენდა / LEGEND

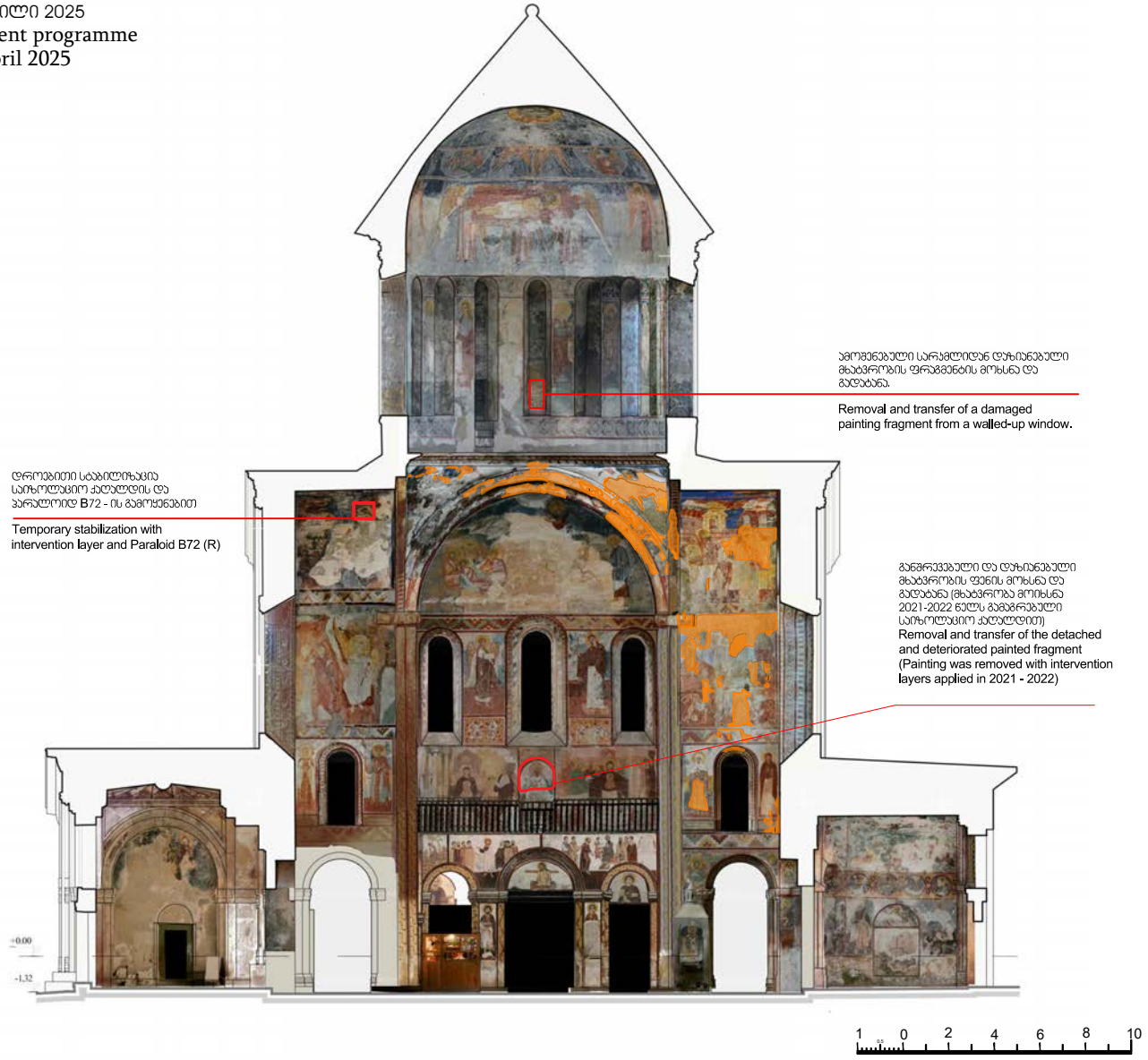
- Grouting
  ჩასხმა (ინექტირება)
- General stabilisation
  ზოგადი გამაგრებები

შედგენის თარიღი 10.05.2024	2/4

გრაფიკული დოკუმენტაცია / Graphic Documentation

საკონსერვაციო ფიზიკური ჩარევების პროგრამა
მარტი 2024 - აპრილი 2025
Remedial treatment programme
March 2024 - April 2025

დასავლეთის ჭრილი
West section



გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

ლეგენდა / LEGEND

- Grouting
  ჩასხმა (ინექტირება)
- General stabilisation
  ზოგადი გამაგრებები

ნედგენის თარიღი 10.05.2024	3/4

გრაფიკული დოკუმენტაცია / Graphic Documentation

საკონსერვაციო ფიზიკური ჩარევების პროგრამა
მარტი 2024 - აპრილი 2025
Remedial treatment programme
March 2024 - April 2025

ჩრდილოეთის ჭრილი
North section

გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

ლეგენდა / LEGEND

- Grouting
  ჩასხმა (ინექტირება)
- General stabilisation
  ზოგადი გამაგრებები

შედგენის თარიღი 10.05.2024	4/4

გრაფიკული დოკუმენტაცია / Graphic Documentation

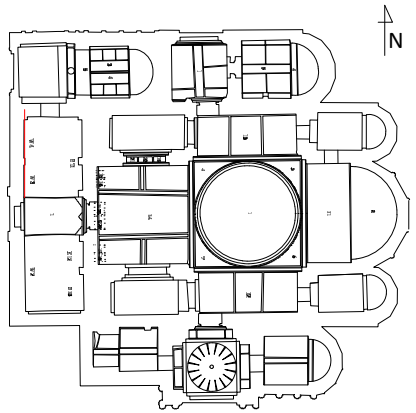
საკონსერვაციო ფიზიკური ჩარევების პროგრამა
მარტი 2024 - აპრილი 2025
Remedial treatment programme
March 2024 - April 2025

0 0.5 1 2 3

გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

გეგმა / Plan



ნართექსი, დასავლეთი კედელი, კამარა
Narthex, West wall, vault

ლეგენდა / LEGEND

Grouting
ჩასხმა (ინექტირება)

General stabilisation
ზოგადი გამაგრებები

შედგენის თარიღი
10.05.2024

გრაფიკული დოკუმენტაცია / Graphic Documentation

საკონსერვაციო ფიზიკური ჩარევების პროგრამა
მარტი 2024 - აპრილი 2025
Remedial treatment programme
March 2024 - April 2025

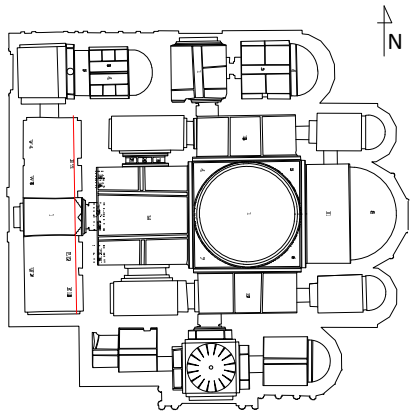
აღმოსავლეთის ჭრილი
East section

0 0.5 1 2 3

გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

გეგმა / Plan



ნართექსი, აღმოსავლეთი კედელი, კამარა
Narthex, East wall, vault

ლეგენდა / LEGEND

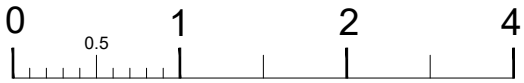
- Grouting — ჩასხმა (ინექტირება)
- General stabilisation — ზოგადი გამაგრებები

გედგენის თარიღი 10.05.2024	2/2

გრაფიკული დოკუმენტაცია / Graphic Documentation

საკონსერვაციო ფიზიკური ჩარევების პროგრამა
მარტი 2024 - აპრილი 2025
Remedial treatment programme
March 2024 - April 2025

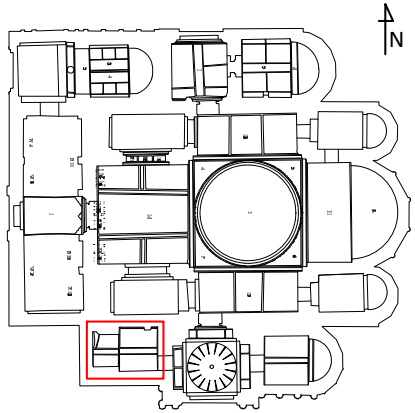
სამხრეთის ჭრილი
South section



გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

გეგმა / Plan



სამხრეთ-დასავლეთი ეკვდერი /
East-West Chapel

ლეგენდა / LEGEND

Grouting
ჩასხმა (ინექტირება)

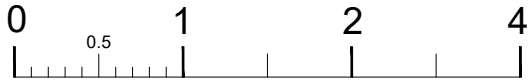
Consolidation + micro-grouting of plaster layer
ნალესობის კონსოლიდაცია + მიკრო-ჩასხმა (მიკრო-ინექტირება)

შედგენის თარიღი
10.05.2024

გრაფიკული დოკუმენტაცია / Graphic Documentation

საკონსერვაციო ფიზიკური ჩარევების პროგრამა
მარტი 2024 - აპრილი 2025
Remedial treatment programme
March 2024 - April 2025

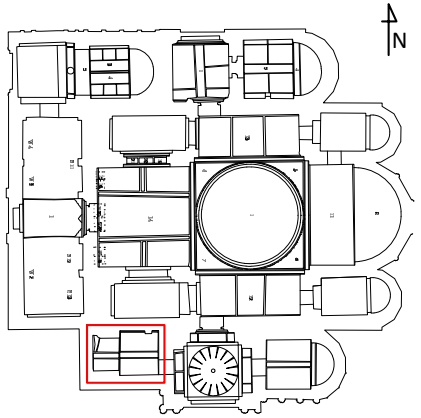
ჩრდილოეთის ჭრილი
West section



გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

გეგმა / Plan



სამხრეთ-დასავლეთი ეკვდერი /
East-West Chapel

ლეგენდა / LEGEND

Grouting
ჩასხმა (ინექტირება)

Consolidation + micro-grouting of plaster layer
ნალესობის კონსოლიდაცია + მიკრო-ჩასხმა (მიკრო-ინექტირება)

შედგენის თარიღი
10.05.2024

4.4

Appendix 2:
Conservation programme timeline 2023–2030

ITEM	completed			ongoing			planned	
	2023	2024	2025	2026	2027	2028	2029	2030
ACCESS PROVISION								
interior: provisional scaffolding								
interior: fixed work scaffold (n, w & s arms)								
interior: fixed work scaffold (dome, narthex n vault)								
interior: fixed work scaffold (narthex s vault)								
interior: small fixed scaffolding for access to Narini Chapel grouting areas								
interior: mobile scaffold for inspection of previously inaccessible areas of chapels/entrances								
exterior: roof: risk assessment/ necessity/feasibity of roofing filler removal								
interior: reconfiguration to allow full access to pendentives,dome supports & window splays								
INFORMATION-GATHERING								
Environmental/condition monitoring								
environmental monitoring to continue for duration of project								
3-d photogrammetry for detailed salts/microbiology/flaking monitoring								
General condition investigations/documentation								
condition assessment/ graphic documentation (main church all arms upper walls)								
condition assessment/graphic documentation (main church all arms lower walls, chapels, entrances)								
condition assessment/graphic documentation (narthex lower walls, Alexander chapel)								
condition assessment/graphic documentation (narthex vault)								
condition assessment/graphic documentation (e arm, dome, narthex vault)								
Salts and moisture: investigations, analysis, monitoring								
priority salts sampling, moisture cores and analysis (Prof. Dr. Laue); monitoring areas selected								
salts monitoring; treatment monitoring (salts reduction); ongoing sampling & analysis								
Microbiology: investigations, analysis, monitoring								
priority microbiology sampling and analysis (Dr. Daniela Isola); monitoring areas selected								
monitoring of microbiology in designated areas, ongoing sampling and analysis								
Technology: investigations & analysis								
initial portable microscopy survey of plaster technologies (entire church)								
plaster sampling for technology information and salts content								
plaster thin section preparation								

ITEM	completed			ongoing			planned	
	2023	2024	2025	2026	2027	2028	2029	2030
Technology: investigations & analysis (continued)								
initial visual/portable microscopy survey of painting technology (entire church)								
targetted visual/portable microscopy/pXRF survey and sampling of painting technology for analysis (main space)								
finalisation of painting technology analysis (main space)								
targetted visual/portable microscopy/pXRF survey and sampling of painting technology for analysis (chapels and entrances)								
further investigations including possible specialist organic analysis								
INITIAL TREATMENT DEVELOPMENT/ IN SITU TRIALS								
nanolime consolidation of infiltration-eroded painting supports (trials: n arm e wall)								
microgrouting with bespoke formulation (trials: n arm e wall)								
sorbent softening of previous repairs in preparation for removal (trials: n arm e wall)								
lime plaster repairs based on wall painting support technology (trials: nw, ne & sw chapels)								
grouting (trials: ne, nw & sw chapel n walls)								
low concentration nanolime paint flake fixing (trials: n arm & pendentives)								
reduction of intractable salts veils and crusts (trials: n arm e wall)								
finalisation of salts veils and crust reduction methodology								
combined stabilisation/salts capture trials in vulnerable areas of efflorescence, flaking and decohesion (trials: n arm w & e walls)								
finalisation of stabilisation/salts capture methodology								
combined stabilisation/salts capture trials in areas compromised by previous treatments: w arm upper walls & vault								
reduction of previous coatings/consolidants: research, analysis (trials: n arm)								
cleaning: infiltration runs, accumulated dirt, graffiti, oil-based overpainting & microbiology: various locations								
EMERGENCY INTERVENTIONS								
Facing of deformed areas of detachment prior to grouting (s arm vault)								
detachment of severely deteriorated painting which cannot be saved in situ (w arm w wall)								
detachment of painting (dome window splay)								
microgrouting (west arm, s vault)								

ITEM	completed			ongoing			planned	
	2023	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
TREATMENT ROLL-OUT								
Stabilisation: general								
flake fixing, consolidation, edge stabilisation, repair removal & replacement including 'critical areas' (n arm, w arm s vault, arches & pendentives)								
flake fixing, consolidation, edge stabilisation, repair removal & replacement (s, w, e arms, dome, chapels, narthex)								
flake fixing, consolidation, edge stabilisation, repair removal & replacement (ground level and previously inaccessible areas: parts of pendentives, dome supports & window splays)								
Stabilisation: grouting								
'critical areas' (n arm, arches & pendentives, s arm s door tympanum, narthex vault central)								
remaining areas of general stabilistation roll-out (n arm, arches & pendentives)								
narthex vault and se chapel								
s, w, e arms &. vaults, dome, remaining chapels								
previously inaccessible areas (parts of pendentives, dome supports & window splays) & ground level								
Salts reduction								
mechanical reduction of efflorescences: all areas except salts monitoring areas								
reduction of intractable salts veils and crusts (n, w, e arm vaults and upper walls, dome, chapels)								
reduction of intractable salts veils and crusts: previously inaccessible areas (pendentives, dome supports & window splays)								
stabilisation in areas of efflorescence, flaking and decohesion (n, w, e arm vaults,upper walls)								
stabilisation in areas of efflorescence, flaking and decohesion: previously inaccessible areas (pendentives, dome supports & window splays)								
Coating reduction								
reduction of previous surface treatments (PVA etc.) where these are causing harm (all accessible areas)								
reduction of previous surface treatments in previously inaccessible areas (pendentives, dome supports & window splays)								

ITEM		completed		ongoing			planned
	2023	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
OPTIONAL PRESENTATION MEASURES								
removal/reduction of infiltration deposits, microbiology, dirt deposits, graffiti (all accessible areas)								
removal/reduction of infiltration deposits, microbiology, dirt deposits, graffiti in previously inaccessible areas (pendentives, dome supports & window splays)								
limited light toning of losses/graffiti (all accessible areas)								
limited light toning of losses/graffiti in all previously inccessible areas (pendentives, dome supports & window splays)								
SPECIALIST TRAINING								
Instruction on salts in conservation/ laboratory analysis by Prof. Dr. Steffen Laue								
Instruction on microbiology in conservation/ laboratory analysis by Dr. Daniela Isola								

Appendix 3:
Graphic documentation of conservation programme 2023–2030

გრაფიკული დოკუმენტაცია / Graphic Documentation

ფიზიკური ჩარევების გეგმა-გრაფიკი
Treatment timeline

აღმოსავლეთის ჭრილი
East section

ჭრილის წყარო: საქართველოს კულტურული მემკვიდრეობის დაცვის ეროვნული სააგენტო

Source of section: Georgian National Agency for Cultural Heritage Preservation

გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

ლეგენდა / Legend

Conservation timeline 2024-2030
2024-2030 წლების - საკონსერვაციო გეგმა

- Completed treatments 2024-2025
  შესრულებული ჩარევები 2024-2025
- Ongoing treatments 2025
  მიმდინარე ჩარევები 2025
- Planned treatments 2026-2029
  დაგეგმილი ჩარევები 2026-2029
- Planned treatments 2030
  დაგეგმილი ჩარევები 2030

გრაფიკული დოკუმენტაცია / Graphic Documentation

ფიზიკური ჩარევების გეგმა-გრაფიკი
Treatment timeline

სამხრეთის ჭრილი
South section

ჭრილის წყარო: საქართველოს კულტურული მემკვიდრეობის დაცვის ეროვნული სააგენტო

Source of section: Georgian National Agency for Cultural Heritage Preservation

გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

ლეგენდა / Legend

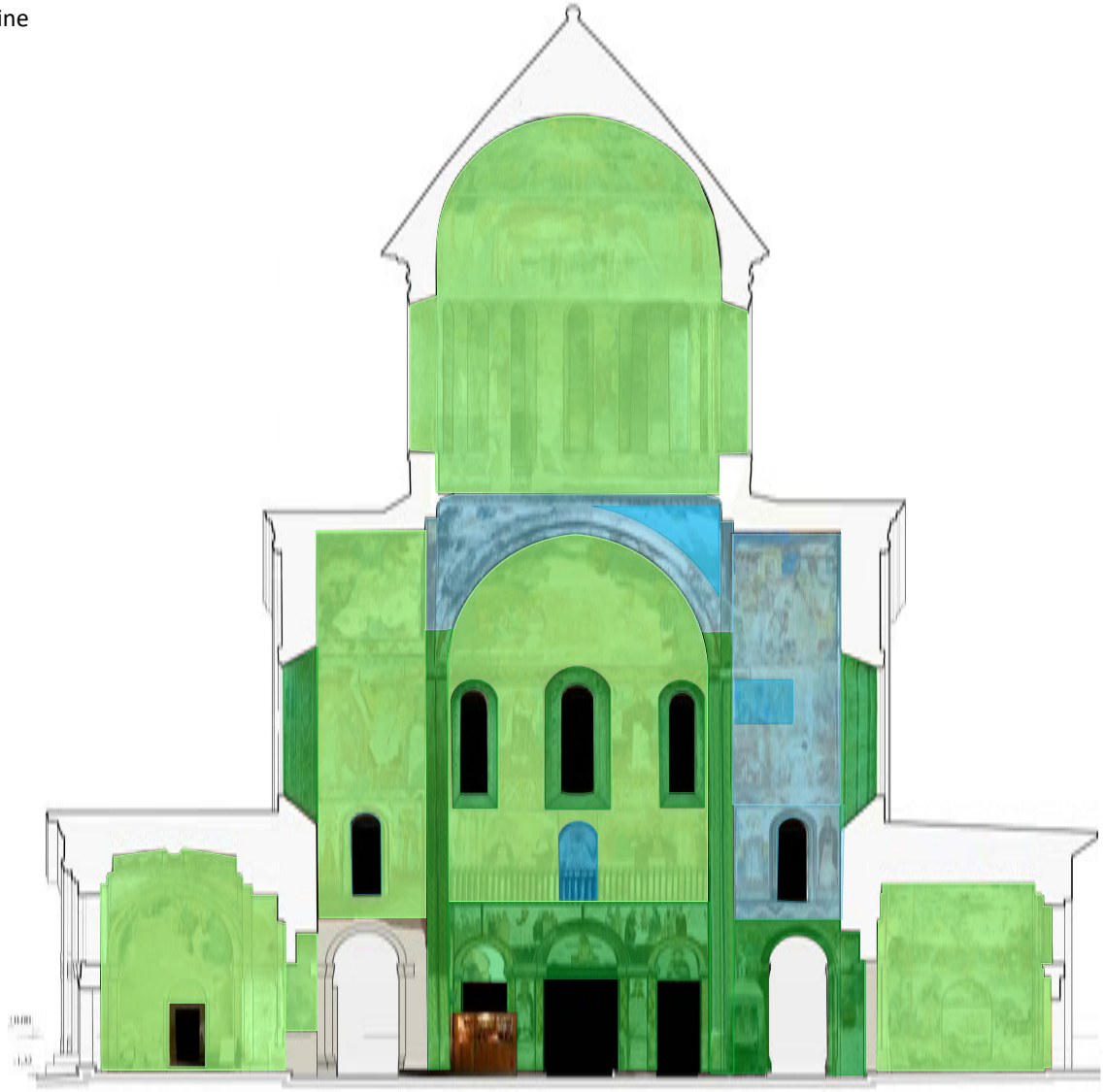
Conservation timeline 2024-2030
2024-2030 წლების - საკონსერვაციო გეგმა

- Completed treatments 2024-2025
  შესრულებული ჩარევები 2024-2025
- Ongoing treatments 2025
  მიმდინარე ჩარევები 2025
- Planned treatments 2026-2029
  დაგეგმილი ჩარევები 2026-2029
- Planned treatments 2030
  დაგეგმილი ჩარევები 2030

შედგენის თარიღი
მაისი / MAY 2025

გრაფიკული დოკუმენტაცია / Graphic Documentation

ფიზიკური ჩარევების გეგმა-გრაფიკი
Treatment timeline



1 0 2 4 6 8 10

ჭრილის წყარო: საქართველოს კულტურული მემკვიდრეობის დაცვის ეროვნული სააგენტრო

Source of section: Georgian National Agency for Cultural Heritage Preservation

დასავლეთის ჭრილი
West section

გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

ლეგენდა / Legend

Conservation timeline 2024-2030
2024-2030 წლების - საკონსერვაციო გეგმა

- Completed treatments 2024-2025
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- Ongoing treatments 2025
  მიმდინარე ჩარევები 2025
- Planned treatments 2026-2029
  დაგეგმილი ჩარევები 2026-2029
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  დაგეგმილი ჩარევები 2030

შედგენის თარიღი
მაისი / MAY 2025

გრაფიკული დოკუმენტაცია / Graphic Documentation

ფიზიკური ჩარევების გეგმა-გრაფიკი
Treatment timeline

ჩრდილოეთის ჭრილი
North section

ჭრილის წყარო: საქართველოს კულტურული მემკვიდრეობის დაცვის ეროვნული სააგენტო

Source of section: Georgian National Agency for Cultural Heritage Preservation

გელათის სამონასტრო კომპლექსი ღვთისმშობლის შობის ტაძარი

The Church of the Nativity of the Virgin Mary

ლეგენდა / Legend

Conservation timeline 2024-2030
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- Ongoing treatments 2025
  მიმდინარე ჩარევები 2025
- Planned treatments 2026-2029
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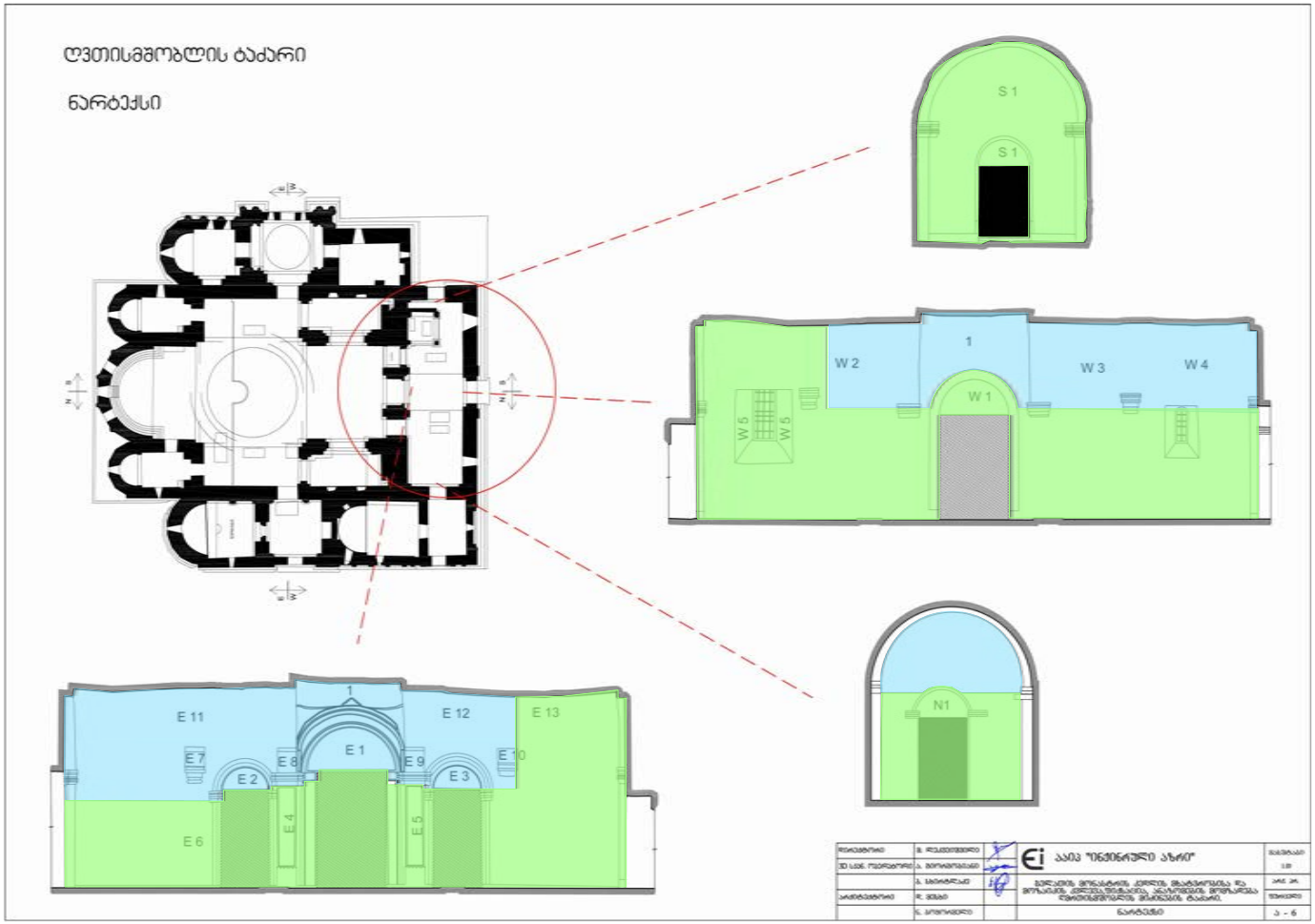
- Planned treatments 2030
  დაგეგმილი ჩარევები 2030

შედგენის თარიღი
მაისი / MAY 2025

გრაფიკული დოკუმენტაცია / Graphic Documentation

ფიზიკური ჩარევების გეგმა-გრაფიკი
Treatment timeline



სამხრეთის ჭრილი
South section

ჭრილის წყარო: საქართველოს კულტურული მემკვიდრეობის დაცვის ეროვნული სააგენტრო

Source of section: Georgian National Agency for Cultural Heritage Preservation

გელათის სამონასტრო კომპლექსი
ღვთისმშობლის
შობის ტაძარი

Church of the Nativity of Virgin Mary

ლეგენდა / Legend

Conservation timeline 2024-2030
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- Ongoing treatments 2025
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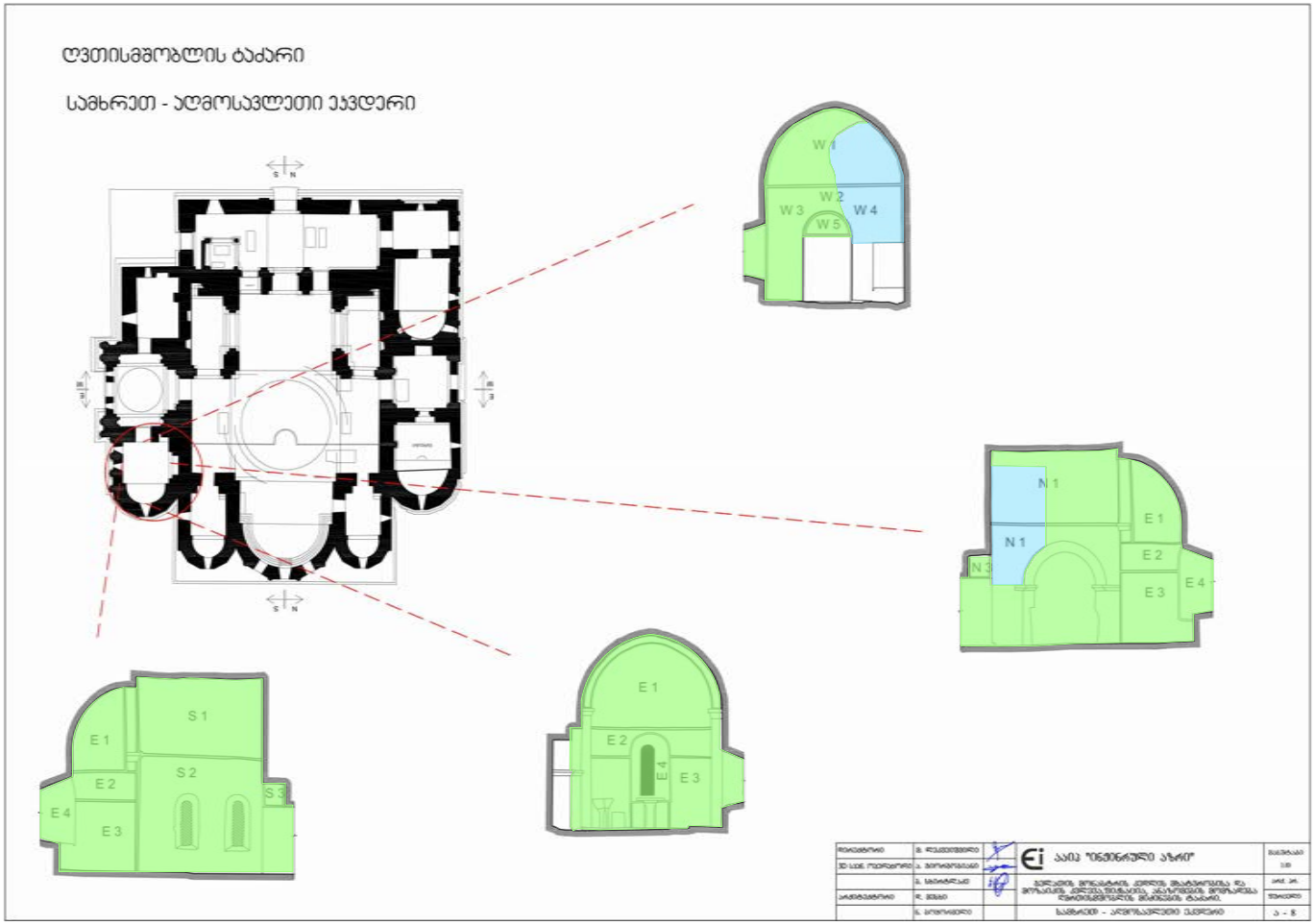
- Planned treatments 2026-2029
  დაგეგმილი ჩარევები 2026-2029
- Planned treatments 2030
  დაგეგმილი ჩარევები 2030

შედგენის თარიღი
მაისი / MAY 2025

გრაფიკული დოკუმენტაცია / Graphic Documentation

ფიზიკური ჩარევების გეგმა-გრაფიკი
Treatment timeline



სამხრეთის ჭრილი
South section

ჭრილის წყარო: საქართველოს კულტურული მემკვიდრეობის დაცვის ეროვნული სააგენტრო

Source of section: Georgian National Agency for Cultural Heritage Preservation

გელათის სამონასტრო კომპლექსი
სამხრეთ-აღმოსავლეთი ეგვტერი

Gelati Monastery Complex
South-East chapel

ლეგენდა / Legend

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  დაგეგმილი ჩარევები 2030

გრაფიკული დოკუმენტაცია / Graphic Documentation

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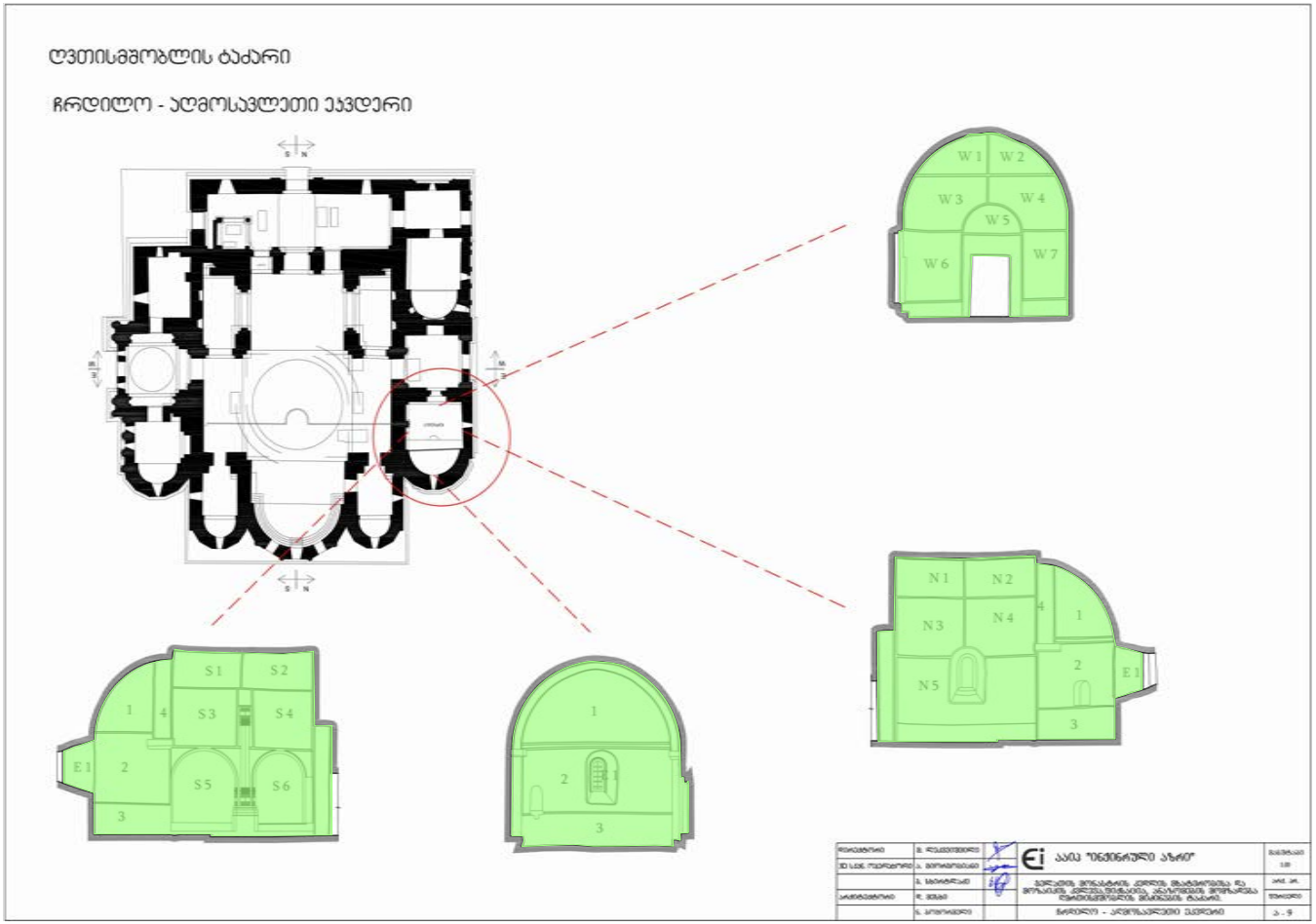

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შედგენის თარიღი
მაისი / MAY 2025

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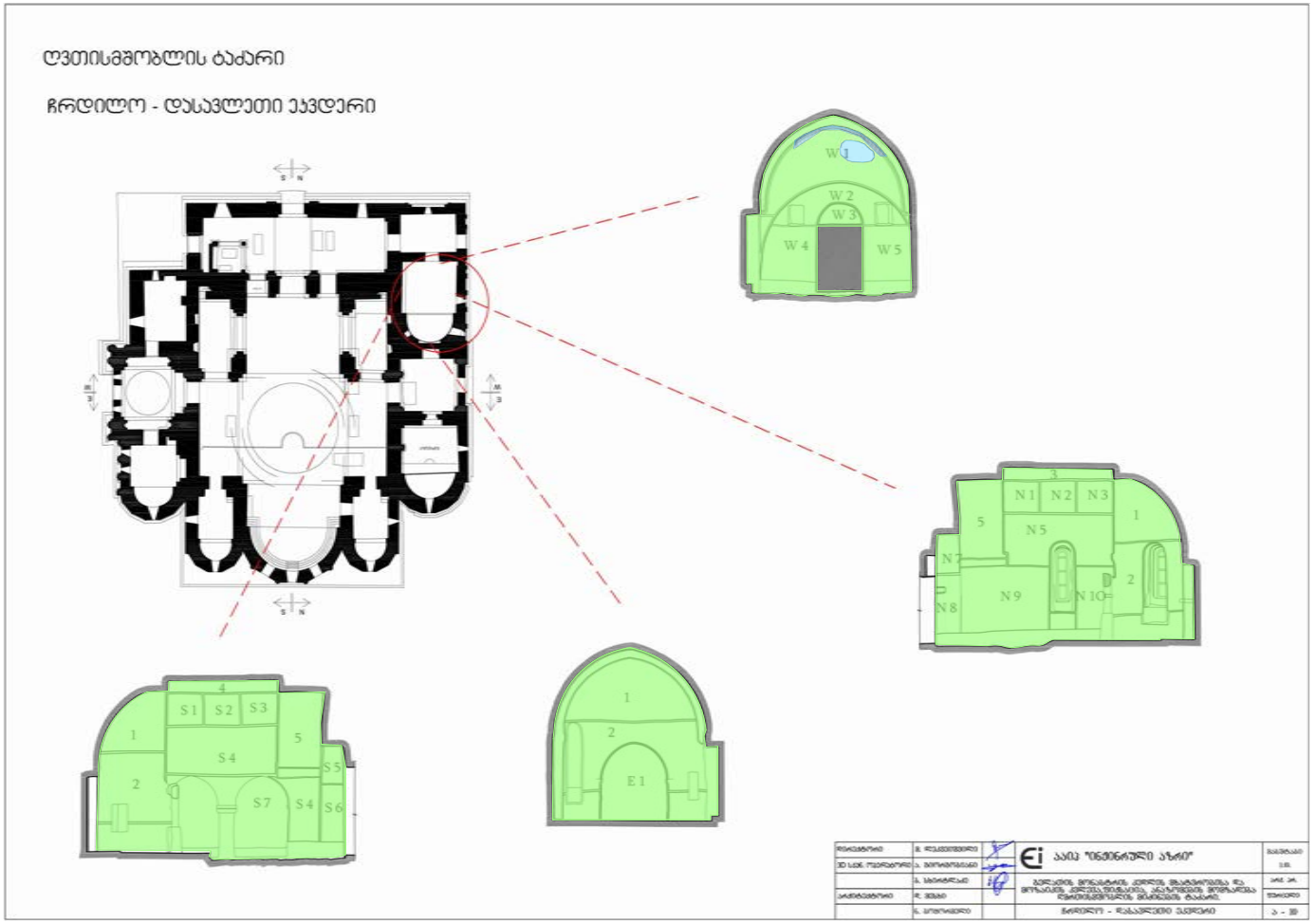

სამხრეთის ჭრილი
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გრაფიკული დოკუმენტაცია / Graphic Documentation

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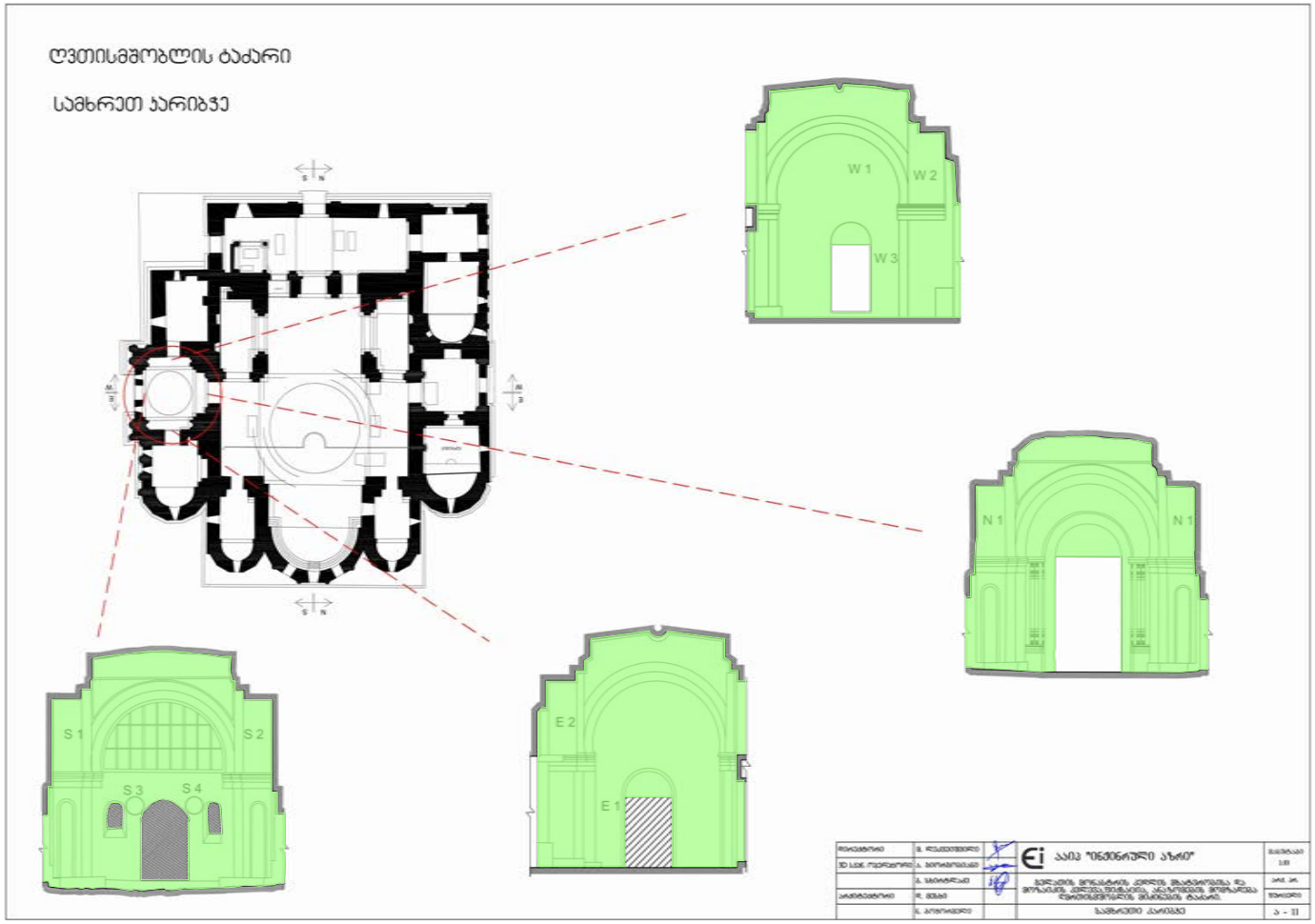

სამხრეთის ჭრილი
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Gelati Monastery Complex
South-East chapel

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გრაფიკული დოკუმენტაცია / Graphic Documentation

ფიზიკური ჩარევების გეგმა-გრაფიკი
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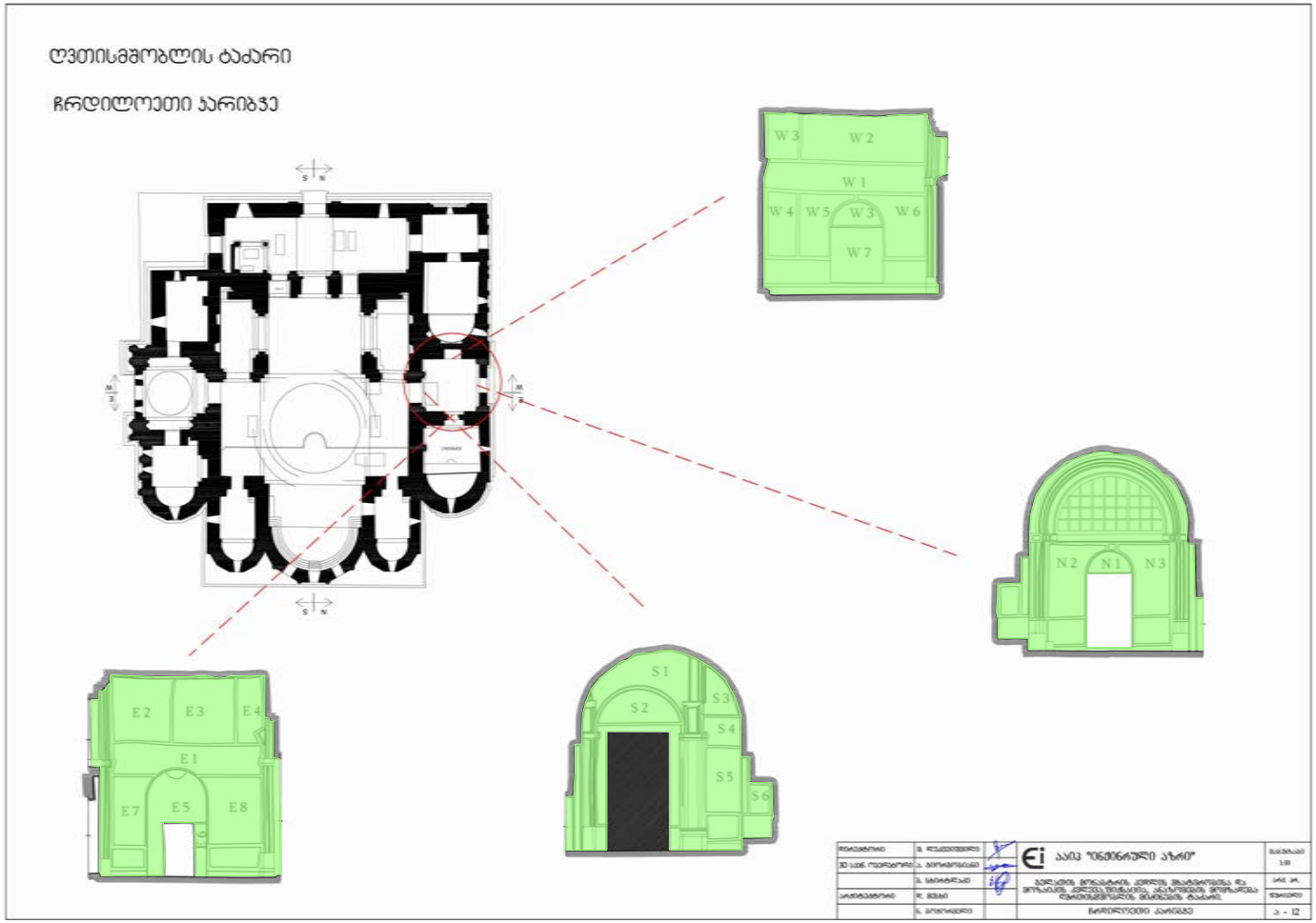

სამხრეთის ჭრილი
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  დაგეგმილი ჩარევები 2030

Appendix 4:
Holistic overview of conservation issues and options

AREAS OF CONCERN			CONTRIBUTION	SOLUTION?	CONSERVATION OPTIONS
general	**specific**	**resulting problem**	major significant minor	none ameliorable yes	**data collection to inform decisions** **passive/preventive measures** **remedial measures**
DETERIORATION					
Inherent deterioration					
climate/ natural environment	extremely variable diurnal and seasonal RH & T fluctuations; periodic heavy rainfall and snow	salts activation			environmental monitoring; salts analysis/monitoring; reduce air exchange with exterior where possible; improve roofing/ rainwater disposal; introduce inspection and monitoring measures so that problems are identified and dealt with early; reduce salts mechanically/poulticing if/where feasible
	light, water (liquid/vapour),	optimum conditions for some microbiological species			environmental monitoring; microbiology analysis/monitoring; increase air movement where possible; identify and remove nutrient sources where possible; reduce microbiology mechanically/ use biocides if/ where feasible
	local hydrogeology	ground-level salts/microbiology			improve drainage and rainwater disposal provision
building design, scale and configuration	weak junctions between multiple abutting roofs; open, inter-connecting spaces; building height/configuration limits access for	liquid water penetration			introduce long-term inspection and monitoring measures so that problems are identified and dealt with early; improve roofing/rainwater disposal/glazing; improve insulation by sealing windows/reducing interconnectivity of spaces.
building fabric (dolomitic limestone)	presence of autocthenous salts (principally Ca, Mg, CO_3)	migration and recombination of salts-forming ions to form new species of salts			environmental monitoring; salts analysis/monitoring; improve roofing/rainwater disposal/glazing; introduce long-term inspection and monitoring measures; reduce salts mechanically/poulticing if/where feasible
painting technology	use of unstable materials including chemically vulnerable pigments, organic binding media & colourants	powdering, flaking and loss of paint, particularly in unstable environmental conditions; colour loss/alteration; provision of microbiological nutrients			paint materials analysis; environmental monitoring; reduce RH & T fluctuations as far as possible by reducing air exchange with exterior/ sealing windows/ reducing interconnectivity of spaces; fixing and consolidation with compatible non-film-forming materiels

AREAS OF CONCERN			CONTRIBUTION	SOLUTION?	CONSERVATION OPTIONS
general	**specific**	**resulting problem**	major / significant / minor	none / ameliorable / yes	**data collection to inform decisions** / **passive/preventive measures** / **remedial measures**
DETERIORATION (continued)					
Contamination					
pollution	eg. blast furnace particulates & sulfates from iron processing	dirt & soluble salts deposition on paint surface			reduce potential deposition by sealing windows/reducing air exchange with exterior; reduce salts mechanically/poulticing if/where feasible
macrobiology	bird and bat faeces	soiling; nutrient source for microbiology; source of soluble ions/ salts (principally Na, P, K, potassium nitrate)			seal windows/reduce interconnectivity of spaces to discourage perching, nesting & roosting; dry/aqueous reduction of soiling; salts poulticing if/where feasible
	historic church burials	nutrient source for microbiology and source of soluble ions (principally Na, P) confined to lower walls			improve drainage if possible
previous conservation materials	cement & gypsum repairs	provoke stress and failure of original plasters; source of soluble ions/salts (principally Na, K, calcium sulphates /carbonates)			remove/replace cement/gypsum repairs where this can be done without causing damage and disruption to the original materials
	inappropriate cleaning materials (ammonium carbonate, EDTA disodium salts etc.)	damage to and loss of painting			none
	film-forming materials: coatings, consolidants & fixatives (eg. polyvinyl acetate, acrylic dispersions & resins)	impermeability increases salts and moisture problems; incompatible hygrothermal properties; nutrient source for microbiology			analytical identification of coating materials; reduction of some materials may be possible in some areas (pending trials)

AREAS OF CONCERN			CONTRIBUTION	SOLUTION?	CONSERVATION OPTIONS
general	**specific**	**resulting problem**	major significant minor	none ameliorable yes	**data collection to inform decisions** **passive/preventive measures** **remedial measures**
DAMAGE					
Accidental/incidental damage					
access provision & building conservation	roofing improvements	risk of destabilisation and loss or vulnerable and delaminating painted vault plaster			minimise vibration-causing activities; employ careful mechanical excavation methods rather than pneumatic drilling
	scaffolding construction/ deconstruction	damage to and loss of painted plaster			none in the case of past damage; ensure scaffolders are professionally trained and supervised for current and future works
general building usage	interior changes, general maintenance (service provision, insertion of fixtures and fittings etc.)	fabric damage, visual and physical disruption, abrasion and loss of painting			none in the case of past damage; to avoid future damage, provide care and maintenance advice to monk-body; cordon off vulnerable areas from the public; ensure invigilation when public are present
	physical contact (touching, leaning, movement of furniture & fittings etc.)	abrasion and loss			
	votive candles	fire damage, soot deposition			
Intentional damage					
human aggression	conflict	eg. historic destruction by fire			none
	vandalism	wilful damage			none in the case of past damage; to avoid future damage, educate the public/reduce access to areas which are partially concealed or have been previously vandalised; ensure invigilation when public are present
		graffiti			