

Gelati Monastery Complex
Wall painting conservation programme

Summary of the activities undertaken
between April 2023 – February 2024

<https://gelatirehabilitation.ge/en/painting>

The wall painting conservation programme (L. Shekede, S. Rickerby)¹ of Gelati Monastery Complex states following required actions:

- Salt investigation and monitoring
- Liquid moisture survey
- Investigation of original technology
- Environmental assessment and related investigations
- Condition assessment and improved monitoring systems
- Planning and implementation of remedial measures.

The initial stages of above-mentioned actions² have been undertaken since April 2023 (see action plan).

Salt investigation and monitoring

Salt monitoring³

Aim: a. To determine salt activity (observation of salt cycles) in relation to time and environmental conditions. b. To determine change of the salt composition (anion content) in the system of structure (on the surface) over the time.

Method: **a. Salt activity** - Regular monitoring of areas with salt efflorescence using imaging method with incident and raking light⁴. Imaging time and environmental condition at that time is recorded and documented. Additional actions: 1. mechanical removal/reduction of superficial salt efflorescence from the selected monitored area; **b. Salt composition (ion content)** - 2. collection of the removed salt samples; 3. in-situ semi-quantitative ion testing of the salts using test strips (Sulphates, Chloride, Nitrate, Nitrite and pH).

Summary of results by February 2024:

- Semi-quantitative ion test results showed high number of nitrates and low number of sulphates in all samples (Church of the Virgin, Main space, Vault level).
- Flake salt activity is mostly on-going; Crust, White Veil and Crystalline dots salt activity – no visible change.

¹ The wall painting conservation programme creators, the wall painting conservation Georgian team leaders/supervisors

² Except liquid moisture survey, which is planned to begin from March 2024

³ Improved method since December 2023, In addition, The International Council of Gelati Rehabilitation Committee has suggested to develop 3D monitoring system, which will be taken into account and implemented in the nearest future.

⁴ Frame of the image and parameters of the camera is required to be same

Salt investigation⁵

	sample type	invasive	information obtainable	analytical techniques
Stage 1	efflorescence sampling	no	qualitative for salt species	aqueous ion analysis; instrumental analysis (XRD, FTIR-ATR, IC etc.)
Stage 2	superficial fabric sampling	no	qualitative and semi-quantitative information on major salts-forming ions	aqueous ion analysis
Stage 3	incremental in-depth fabric sampling	yes	nature and stratigraphic distribution of major salts-forming ions	micro-core drilling into the fabric/ aqueous ion analysis/ instrumental analysis (FTIR etc.)
Stage 4	whole samples	yes	identification of salts sources; morphology; distribution within stratigraphy; elemental and limited species analysis	polarised light microscopy; cross-section/limited stain testing; SEM-EDS; thin-section etc.

Figure 1 Sampling types and analytical techniques for salt investigation of samples [after Bläuer Böhm 1996]

Aim: The identification of the salt species presents as efflorescence to help indicate the environmental parameters for phase transitions and suggest possible sources.

Method: Figure 1. Shows stages of salt investigation from the conservation plan. So far Stage 1. Efflorescence sampling has been undertaken, which will be continued in combination with following stages from March 2024.

The first stage of the analytical investigation of salts: 1. Selection of the locations of salt efflorescence on the wall paintings of the vault level at the Nativity of the Virgin Mary. Sampling locations should include different types of salt efflorescence: flakes, crystalised dots, crust, white veil. 2. In the initial stage, taking up to 10 samples from the wall paintings and production of the relevant sampling documentation. 3. Packaging of samples and sending them to the laboratory of the University of Applied Sciences, Potsdam in Germany to Prof. Steffen Laue for analytical investigation. 4. Undertaking analytical investigations, data processing and interpretation before March 2023. This phase will allow the salt research group to determine the general picture and strategy in advance, and based on this material, within the framework of the March 2023 mission, carry out large-scale salt investigation work.

Results:

The analyses on the samples have not been completed. The detailed report on this analyses series will be sent in mid-March 2024.

Preliminary report presents results of the samples, which were analyzed microscopically and using X-ray diffractometry (XRD). An Empyrean X-ray diffractometer from Malvern Panalytical with CuK α radiation was used to determine the salt phases. The samples showed following composition: Niter, Aphtitalite, Picromerite, Syngenite, Dypingite, Gypsum, Hydromagnesite, Nequehonite, Hexahydrate.

[Preliminary Report of Salt investigation FHP \(Prof. Dr. Steffen Laue\) Feb 2024](#)

⁵ Sampling and analytical research. The Document will take into account the recommendations from the local and International Councils of Gelati Rehabilitation Committee

Environmental assessment and related investigations⁶

Aim:

- Determine impact of macroclimate on microclimate
- Determine additional sources of moisture
- Determine impact of the environment on wall paintings, particularly:
 - Salt related problems: cycles of crystallization and deliquescence of the salts in the structure of the wall (in the primary and secondary support and in the paint layer, as well as on the surface), which deteriorates the paintings (contributes to the failure of the cohesive and adhesive bond within and between the layers). Together with salt investigation determine environmental conditions (range) when salt phase change happens (is at risk to change) at Gelati.
 - The risk of condensation on the surface of the painting, which in turn will exacerbate salt-related problems.
 - Failure of the cohesive and adhesive bond within and between the stratigraphic layer of the wall painting.
 - Activation of microbiological deterioration.
- Determination of drying process (rate) of the building structure in relation to the function of openings and roof removal
- Development of the mitigation measures (together with wall painting, architecture and other experts) to regulate the environment in order to slow down salt activity and wall painting deterioration process.

Method: The monitoring (per hour) of the relative humidity, absolute humidity (Calculated), ambient temperature, dew point temperature (Calculated) at the two levels (vertical elevation) of the main space of the Church of the Virgin Mary, one level monitoring of the chapels, entrances and narthex. One level monitoring of the St. George Church. The exterior sensor monitors T, RH, AHcal, DPTcal. The weather station (in the exterior) also monitors minimal, maximal and average of atmospheric precipitation (rain), wind direction and speed (every 10 minutes).

[Environmental monitoring methodology](#)

Summary of results by December 2023: 3-year environmental monitoring data has been graphed⁷. Annual, seasonal and monthly data shows rapid fluctuation of the humidity and temperature. The exterior is the main source of the interior climate, high humidity levels and risk of condensation during the Spring and Summer seasons. Flake salt activity responds to the environmental conditions especially on the vault level of the main space of the church of the Virgin.

[Environmental Monitoring Graphs 2020 - 2022](#)

[Environmental Monitoring Graphs 2023](#)

Investigation of original technology

Aim: understanding original technology (materials and techniques of plastering and painting) in order to better determine deterioration mechanism, causes and develop safe and appropriate conservation

⁶ The Document will take into account the recommendations from the local and International Councils of Gelati Rehabilitation Committee

⁷ The data of 2020 – 2021, 2021 – 2022 has been graphed, the data of 2022- 2023 with rainfall and wind (speed and direction) will be submitted at the end of January.

interventions.

Method:

Stage 1. Non-invasive investigation/technology survey: visual observations and documentations (photo, graphic, textual) to determine painted schemes, record characterisations of the whole.

Stage 2. Determination of research questions and analytical sampling strategy and undertaking analytical investigation.

Stage 3. Data collection and interpretation

Investigations undertaken from April – February 2024 – Stage 1. Technology survey – The church of the Virgin, the main space (All 4 tiers/ whole space).

Summary of the results by December 2023:

The main space of the Church of the virgin has at least 4 painted schemes (Early (12th?), 16th, 17th and 19th (overpaint) cc). The visual observations/survey revealed following:

- ✓ Primary support: one type of rock (similar to sedimentary carbonate rock) and mortar (greyish-white colour, strong, dense, multiple inorganic fillers).
- ✓ Secondary support and preparatory techniques:
 - Painted scheme 1 (early)
 1. Plasters: 3 main categories of plaster: 1. unidentified unpainted plaster patches, 2. the main plaster layer 3. preparatory layer.
 2. Preparatory techniques: red underdrawings
 3. Paint: blue, red, green, yellow

- Painted scheme 2 (XVI) + additional painted plaster patches

Plasters: 5 main categories of plaster, which has white binder and mainly differs according to the inclusions(fillers): 1. inclusions: relatively large amount of inorganic aggregates + yellow organic inclusions; 2. inclusions: relatively large amount of inorganic aggregates + yellow organic inclusion + transparent white organic inclusion; 3. inclusions: only the yellow organic inclusion; 4. inclusions: small amount of inorganic aggregates + transparent white organic inclusion; 5. inclusions: A large number of inorganic aggregates + transparent white organic inclusions. 6. inclusions: larger inorganic aggregates and organic inclusions

Preparatory techniques:

Setting out Geometry: compass, snapped lines, incised lines.

Underdrawings: incised lines, painted lines.

Paint: 3 types of blue, 2 types of green, 2 types of red, 3 types of yellow, 2 types of orange, 3 types of gold, 1 type of white, black, brown.

According to the painting style and partly technology there is more than 1 scheme within the XVI c layers.

- Painted scheme 3 (XVII)

Plaster: similar to type 3 plaster (from 16th c) with only organic inclusions.

Use of small and narrow tool marks

Preparatory techniques:

Setting out Geometry: compass, snapped lines, incised lines.

Underdrawings: incised lines, painted lines.

Paint: Limited colour pallet dominating gradations of reds.
yellow, red, white, black.

- Painted scheme 4 overpaint (XIX)

Plaster: type 5 from Painted scheme 2 (XVI) - inclusions: A large number of inorganic aggregates + transparent white organic inclusions.

Preparatory techniques: remains from lower painted scheme (2).

Paint layer: oil-based painting

Reports⁸:

[Wall painting technology and condition assessment summary, December 2023 in English](#)

[Report of April 2023 in Georgian](#)

[Report of October 2023 in Georgian](#)

[Report of December 2023 - Graphic documentation of II, III, IV tiers of the main space of the Church of Virgin in Georgian and English](#)

[Report of February 2024 in Georgian](#)

Wall painting condition assessment and monitoring

Wall painting condition assessment:

Aim: Determination of condition phenomena (in combination with original technology) in order to better determine correlation between deterioration and their mechanism, causes and develop safe and appropriate conservation interventions.

Method: Stage 1. Non-invasive investigation: visual observations and documentations (Photo, graphic, textual) to determine wall painting condition phenomena according to stratigraphic layer and deterioration/damage types. Stage 2. Determination of research questions and analytical sampling strategy and undertaking analytical investigation. Stage 3. Data collection and interpretation

Summary of the results by December 2023:

The main space of the Church of the virgin has wide range of condition phenomena, which has been documented through visual glossary and graphic documentation.

⁸ Documents will be updated at the end of February 2024. The latest documents will have included all tiers of the main space.

Primary support:

- Loss of mortar
- Cracks of stone
- Decohesion of stone

Plaster layer:

- Loss (Full and partial)
- Cracks (Net type and lines)
- Delamination (closed and open between 1. Plaster layer 2. plaster and support)
- Decohesion
- Pitting

Paint layer:

- Loss (Full and partial)
- Cracks
- Cohesion failure
- Adhesion failure (flaking, blistering)
- Drips
- Alteration

Superficial deposition: dust, dirt, particular matter, cobwebs, excreta

Bioactivity: Black and pink micro-organisms

Salts: Flake, crust, white veil, crystalline dots

The condition of the wall paintings in the Church of the Nativity of the Virgin Mary and St. George, of the Gelati monastery complex is severe. Both stable and active deteriorations can be seen. The following areas of the main space of the Church of the Nativity of the Virgin Mary are especially critical: the southern wall of the western arm (S7, S8), the western Pendentive and the adjacent arches, as well as certain sections in the northern (W7, W9, E5, E7, E9) and southern arms (W8, S12).

Reports⁹:

[Wall painting technology and condition assessment summary, December 2023 in English](#)

[Report of July 2023 in Georgian](#)

[Report of October 2023 in Georgian](#)

[Report of December 2023 - Graphic documentation of II, III, IV tiers of the main space of the Church of Virgin in Georgian and English](#)

[Report of February 2024 in Georgian](#)

⁹ Documents will be updated at the end of February 2024. The latest documents will have included all tiers of the main space.

Wall painting condition monitoring

Aim: a. To determine deterioration activity (observation of deterioration change) in relation to time and environmental conditions and salt activity.

Method: deterioration activity - Regular monitoring of areas with deterioration using imaging method with incident and raking light. Imaging time and environmental condition at that time is recorded and documented.

Summary of the results by February 2024:

The wall painting at Gelati monastery complex has wide range of condition phenomena. According to wall painting deterioration rate, the active (with rapid change), ongoing (with relatively slow change) and stable (visually no change) areas can be found. The active deterioration process (loss, powdering, flaking) is ongoing mostly on the upper tiers of the main space of the church of the Virgin, St Marine Chapel and on the north wall of the St. George's church.

The observation of the condition revealed change in the (flake) salt efflorescence on the wall paintings. The Crystallization-deliqescence cycles of salts and the sensitivity of the materials to moisture lead to the deterioration of the condition of the plaster and the paint layer - decomposition and subsequent loss.

Reports¹⁰:

[Monitoring report \(March/April, July, October 2023\)](#)

[Monitoring report \(July, October, December 2023\)](#)

[Monitoring report \(December - February 2024\)](#)

Result of meteorological disaster 2024 February 5-6

Context: On February 5th and 6th, 2024, Western Georgia and in particular the region of Imereti where the Gelati monastery is located, was hit by a big storm, state of emergency was declared. The damage caused by the storm not only affected buildings and infrastructure but also human lives¹¹.

The national weather station located inside the monastery detected wind speeds of over 110 km/h with peaks of 115 km/h. With prevailing south/west direction.

In addition to the wind, the storm was also characterized by heavy rain. The combination of intense winds and rain had a great impact on the Gelati monastery complex, in particular on the Churches of the Nativity of the Virgin Mary and St. George.

Summary of the report: The paintings remain at risk as long as there is inadequate protection against heavy/ driving rain. The recent rainwater infiltration problem has badly affected the main church. The areas most severely affected are the northern wall of the western arm and the east wall of the narthex. Other affected areas include paintings near west windows of the west arm. Approximately 15 m² of painted plaster in the church of Virgin is visibly affected. Ingress points are multiple, primarily window openings and joints where the temporary roofing abuts the fabric of the church. Rainwater infiltration in the church of St George is confined to a single point in the south column of the nave (?). This is thought to result from rainwater entering from the dome openings, slightly affecting an area of approximately 1 m². Addressing defects in the current roofing and window sealing is at the moment the most important

¹⁰ Report of January-February 2024 will be uploaded at the end of February 2023.

¹¹ [Report on the urgent monitoring mission implemented on February 7, 2024, V. Zesashvili](#)

conservation priority.

While infiltration problems are still occurring remedial treatment in affected areas is not appropriate and could exacerbate problems. Conservation efforts in affected areas should concentrate on moisture and salts investigations and monitoring.

Remedial conservation efforts should concentrate on materials development, testing, and treatment in non-affected areas.

Report:

[Result of meteorological disaster of the 5-6 February, 2024 reflected on the Gelati Monastery Complex](#)

Research into physical history

[Report December 2023 in Georgian \(p. 1-22\)](#)

[Report of February 2024 in Georgian](#)

Planning and implementation of remedial measures

Recent treatment failures and associated worsening of condition indicate the limitations of remedial options at Gelati. Even well-formulated remedial measures identified as necessary must now be viewed with extreme caution, recognizing the high risks of exacerbating harm and causing other unintended consequences. A critical consideration is that salt contamination can be regarded as a permanent addition to the fabric, which introduces conditions of continual change that constrain remedial options and undermine their outcomes. A further important consideration that must be recognized is that the paintings cannot tolerate new cycles of major retreatment and treatment failure. Even so, ongoing loss of original materials and conditions of imminent risk of loss need to be addressed by specific stabilization interventions.

It is not useful to view these conditions as emergency situations that require an immediate, one-time response, however. Rather, a cautious and incremental approach must be adopted based on a case-by-case evaluation of need, and the calibration of remedial treatments to particular and differing circumstances.

Summary of the results by February 2024: The wall painting conservation team has determined critical areas, which have severe condition phenomena and are in a higher risk of loss and according to the conservation plan, has proposed actions recommended to be undertaken for each of individual cases. It is considered to be advisable to undertake emergency temporary stabilisation works on few cases, some of the cases suggests no remedial interventions at this stage.

Reports:

[Graphic documentation of critical areas](#) in Georgian and English

[Action plan of critical areas¹²](#) linked with photo documentation in English.

¹² The Document will take into account the recommendations from the local and International Councils of Gelati Rehabilitation Committee

Further details for undertaken and planned wall painting conservation activities can be seen in a following document:

Action plan and timetable for wall painting conservation programme (2023- 2027)

Note: The provided action plan and timetable document is a living document, therefore, it will be constantly updated.

The above-mentioned documents were created by Georgian wall painting conservation team members under the **international supervision** of **Lisa Shekede** and **Stephen Rickerby (Expert conservators)**.

Georgian team members:

Mariam Sagaradze and Lela Ninoshvili (Internal co-supervisors of the Georgian team, senior conservators)

Sophio Mikaberidze and Nana Khuskivadze (Senior conservators)

Erekle Naroushvili (Middle conservator)

Mariam Todua, Ella Saakiani and Eter Toloraia (Junior conservators)