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The Southern Chamber of Amun belongs to the Complex of Amun-Re, which is located on the Upper Terrace of the Hatshepsut Temple. The entrance to the chamber is through a doorway in the southern wall of the Upper Courtyard, close to its western end, on the left side of the granite gate of the Sanctuary of Amun-Re.

The decoration of the chamber can be considered as one of the best preserved original wall-paintings in the temple, with full scenes which present Queen Hatshepsut and Tuthmosis III making offerings to Amun-Re and Amun-Min. The chamber is one of the few places in the temple where images of Hatshepsut have survived, though her names in cartouches were changed. The representation of the queen executed in refined relief on the southern wall of the chamber shows her in kingly costume, including royal beard, white crown of Upper Egypt and white pleated kilt. Her complexion was rendered with red ochre.

The conservation and restoration project started in 2006 and was continued through 2007,[1] covering the following stages:

— preliminary survey,
— construction work,
— development of optimal conservation methods based on selected media,
— conservation and restoration of the wall painting and relief,
— esthetical arrangement of lacunas in the limestone.

First, the condition of the painting was analyzed with the objective of recognizing degradation processes. Exposure to water, dust, sand and stone debris coming through a hole in the ceiling, where a big cuboidal block of limestone is missing were found to be major causes of damages to the painted reliefs. The block must have fallen during one of the earthquakes at an unspecified time in the past.

The central part of the south wall proved to be the most affected area. The painting layer which originally covered the representations of Amun-Re was damaged almost completely. Colors had been washed away and the smooth surface of the stone had been abraded by dust transported in the rainwater. The same process caused the disappearance of polychromy from the

1 The conservation team comprised the following: Izabela Uchman-Laskowska (Chief Conservator, Academy of Fine Arts in Warsaw), Monika Czerniec, Marlena Koczorowska-Pyzik, Maria Podkowińska-Lulkiewicz.

Fig. 1. South wall of the chamber with an image of Hatshepsut making offerings to Amun, during conservation and restoration (Photo M. Jawornicki)

north wall of the chamber above the doorway. No traces of colors have been preserved on the offering vases carved just below the gap in the ceiling.

The entire surface of the decoration was covered with a thick layer of accumulated dirt and pollution. Sand and dust carried by desert winds had settled on the chamber walls. Various salts migrating from the stone blocks generated the accumulation of mineral compounds on the surface. Recrystallization of gypsum supported the formation of a consolidated patina layer that effectively concealed the original coloring of the painting. This secondary accumulation results in more than just visual disfiguring, as it can also cause abrasion, trap pollutants and water on the painted surface, leading to further decay.

Damage caused by bat excrements covering the polychromy in the upper parts of the walls is of a different kind. Chemical compounds from the thick black guano layer, which has the capability to absorb moisture, lead to decay of the binder and lack of cohesion of the painting. This is a serious problem faced by conservators of ancient Egyptian wall paintings (i.a., Capriotti 2004).

The state of the limestone support was quite good. Blocks cut from dolomitic limestone (for stone identification, see appendix below) were in satisfactory condition and the typical damage recorded was mechanical. This type of rock is relatively

Fig. 2. Close-up of a representation of Amun, before (left) and after restoration (Photo M. Jawornicki)

soft, 3 on the Mohs hardness scale (Nicholson and Shaw 2003: 40), hence long exposure to abrasive action by sand and dust coming in from outside has resulted in destroyed edges and corners of the blocks.

Parts of the relief decoration were intentionally changed in pharaonic times. It was important to distinguish these ancient interventions in the decoration of the chamber in order to understand particular types of damages and reconstructions. The original decoration was changed mainly on the west wall. The indistinct outline of a foot just above the dado is the only trace of a big figure which had been carved there before. This foot probably belonged to a representation of Queen Hatshepsut making offerings in front of Amun-Min.

On the opposite wall, there is a scene showing Tuthmosis III in the same action, so perhaps the decoration of the east wall was originally intended as a mirror image of the one on the west wall. The figure of Hatshepsut was subsequently removed and on the smooth surface of the stone blocks an offering table was carved. Interestingly, however, the representation of the royal *ka* survived this destructive "restoration".

The other figure of Hatshepsut in the company of the goddess Amaunet was located on the north wall of the chamber, just beside the doorway. Traces of disfiguring chiseling are visible on the surface of the queen's representation, but they do not disturb the general form of the relief. This kind of "unfinished" and "cursory" destruction can be compared with a similar case in the Northern Chapel of Amun, where Hatshepsut's figures were treated in the same way.[2]

Different types of intentional damages were observed in parts of the figures of the goddess Amaunet and the gods Amun-Re and Amun-Min. The original relief was disfigured by chiseling during the Amarna period. Reconstructions later in pharaonic times were based on a technology which did not guarantee long lasting preservation. Damaged figures were restored in mineral plaster containing a substantial amount of gypsum. Lack of sufficient adhesion to the smooth surface of the stone led these secondary layers to become detached from the wall. This conservation problem had to be addressed urgently.

At the time when parts of the temple were adapted for use in the Coptic monastery of Saint Phoibammon, the

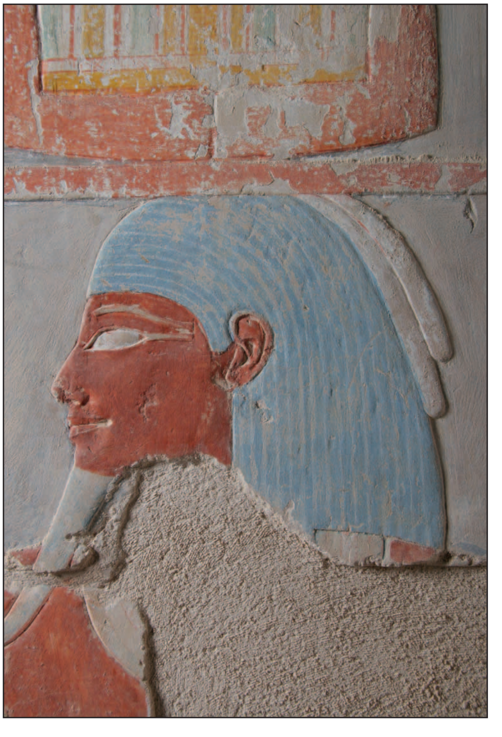

Fig. 3. Polychromy on the royal ka, after restoration (Photo M. Jawornicki)

2 For particulars, see the conservation report for the 2004–2005 seasons in the mission's archives.

described chamber was also partly rearranged. The main interference was opening a passage between the Chapel of Tuthmosis I and the Southern Chamber of Amun. The original doorway to the courtyard was blocked and arranged as a niche which was decorated with red graffiti (Godlewski 1986: 39–41).

The safety of the relief and wall painting required closing the open space in the middle of the ceiling. For this purpose a structure made of a wooden panel supported by tie-beams was designed and built by Mieczysław Michiewicz. The underside of the panel was covered with color imitating the mortar used for filling gaps and losses in the limestone.

The next step toward the conservation and restoration of the ancient decoration was the urgent intervention needed to preserve the post-Amarna mineral plaster reconstructions. A similar problem faced restorers working on the restoration of the Northern Chapel of Amun in the 2004/2005 season. The findings and conclusions resulting from that project were instrumental in developing the best conservation approach for the current work. The extension and the depth of the detachment were carefully checked by tapping the plaster layer. Surface tension was reduced by injections of ethyl alcohol mixed with water (1:1) which were applied into the empty pockets between the plaster and stone. The first phase of consolidation was achieved by injections of a water dispersion of acrylic resin PRIMAL AC33 (by Rohm&Haas). Once plaster adhesion reached optimal levels, the mineral components were reinforced. The weak and

Fig. 4. Figure of Hatshepsut, close-up after restoration (Photo M. Jawornicki)

porous structure of the ancient plaster was impregnated with FUNCOSIL STEINFESTIGER 300 (by Remmers). This substance, which contains esters of silicic acid, was applied in conditions of high humidity to attain the best consolidation results.

Removing the thick layer of pollution and salts described above required the development of optimal conservation methods based on selected media. The treatment had to be adapted appropriately to the thickness of the layer and its chemical composition which differed from section to section of the decoration.

Cleaning the surface of ancient monuments is an action not only technical, but also artistic. Decisions to remove accumulations and patina should always be considered in the context of the safety of the original material and its aesthetic consequence: "A restorer is almost always a creator of aesthetic values of the restored artefact" (Korpal 2004: 77). Preliminary tests demonstrated the effectiveness of pastes based on sepiolite, a polymorphic variant of talc which can be a carrier for active substances. Different types of cleaning pastes were prepared, containing distilled water, Klucel G, ammonia water, water solution of ammonia carbonate and sodium versenate, appropriately to the character of particular accumulations. These chemical agents were also used in tissue compresses applied on the surface of the pollutants, covered with aluminum foil to limit vaporization of the agents. Application time of pastes and compresses was suited to the thickness of accumulations and color resistance.

The original coloring of the reliefs, which is still quite bright, was revealed as a result of these procedures. Plant gums identified as an adhesive in the painted decoration of the chamber[3] have very good optical properties. They are highly photostable. Water soluble gums (especially acacia gum) were a common binder in ancient Egyptian painting and their specific identification is still under study (Newman and Halpine 2001). Modern analytical procedures can distinguish to a certain extent adhesives originating from different types of trees by analyzing the kinds and relative amounts of simple sugars and sugar acids in their content.

Some parts of the painting layer required reinforcing. A tendency to become pulverized was observed especially in the case of Egyptian blue, which is quite coarse-grained. The parts containing red ochre also needed strengthening. The decay of the binder due to natural ageing processes caused a lack of cohesion.

The following factors were taken into account when selecting the adhesive media for the consolidation process:

– compatibility with original technique and technology of painting,
– treatment effectiveness,
– reversibility,
– adaptability of application method to the condition of the painting layer,
– coordination with cleaning methods.

Three types of consolidation media were selected for different kinds of detachment based on up-to-date conservational practice (cf. Daniels n.d. and Uchman-Laskowska 2003: 70–79):

1. KLUCEL G (hydroxypropylcellulose), for parts of painting with a tendency toward becoming pulverized, 4–6% water solution with ethyl alcohol,
2. Arabic gum (*Acacia senegal*), for reinforcing the original binder of the painting,

3 Identification of organic binders by Dr. Irmina Zadrożna.

Fig. 5. East wall of the chamber after restoration (Photo M. Jawornicki)

3. PARALOID B-72 (methyl acrylate and ethyl methacrylate), for consolidation of highly decayed parts covered with bat excrements, 2–3% solution in acetone and toluene.

All of these media were either sprayed on or brushed on, giving positive effects.

The last stage of the project was to fill all lacunas in the limestone. The conservation method combined protective and aesthetic aspects. The main aim of the work was to support parts of the stone blocks which were exposed to damage by filling gaps between them with special mortar. The composition of the mortar was prepared so as to ensure that it met the following requirements:

– compatibility with the limestone,
– mechanical resistance in conditions of low humidity,
– reversibility,
– color and structure adapted to the original surface of the stone and painting.

Very deep gaps had to be filled with a double layer of mortar.[4] The bottom layer consisted of one part white cement, one part lime and three parts sand medium sieved. The upper layer had the following components: seven parts white cement, five parts lime, five parts white lime dust fine sieved, five parts yellow mineral dust fine sieved and one part sand fine sieved.

The surface of the mortar was recessed 3 mm compared to the surface of the original limestone blocks to make them clearly visible and distinctive from the restoration layers.[5]

The conservation project effectively restored the painted relief to its original artistic and display values and achieved the objective of clarifying the decoration program of the chamber. The project was supported by comprehensive research carried out at the Faculty of Conservation and Restoration of Works of Art of the Academy of Fine Arts in Warsaw.

APPENDIX

MATERIAL ANALYSES OF SAMPLES OF ROCK AND PAINTING LAYERS FROM THE SOUTHERN CHAPEL OF AMUN IN THE TEMPLE OF HATSHEPSUT IN DEIR EL-BAHARI

The analyses were carried out by Irena Koss (rock) and Anna Zatorska (painting layers) in the Specialist Analyses and Documentation Techniques Lab of the Faculty of the Conservation and Restoration of Art Works of the Academy of Fine Arts in Warsaw.

ROCK ANALYSIS

The analyses of rock samples from the Southern Chapel of Amun were designed to determine the reasons for color changes in the rock matrix of the chapel. The rock, which is a pale beige color on the whole, takes on a dark beige or dark gray color on

4 Qualified Egyptian workers Al-Azab Sayed Yassen, Ali Mahmud Mansur and Mohamed M. Basry participated in this phase of the project.

5 This method conforms to restoration principles adopted by the Mission, cf. Gazda 2001: 207.

the surface as well as under the surface to a depth of from a few millimeters to 2 cm. The observed changes could be due to organic elements in the painting layer as well as non-organic mineral constituents in the composition of the rock.

Due to the small size and quantity of the rock sample examined, the focus of the analyses was on processes concerning potential mineralogical, non-organic changes. This approach was dictated also by earlier determinations on rock samples taken from the Northern Chapel of Amun. The small quantity of the material then did not permit a satisfactory set of instrumental analyses to be carried out in search of both organic and mineralogical changes. In the present research, mineralogical changes were assumed, together with migration and changes in elemental composition (Ca, O, Mg, Al, Si, Fe) in the rock samples that were changed in terms of their color.

Thin sections were made for observation in transmitted light, polarized light under a polarizing microscope, microchemical examination and instrumental analyses: XRD diffractive analysis; observation under an electron microscope, SEM point and planar (mapping) electron microprobe analysis and spectral analysis (X-ray spectrometer); photographic documentation. Examination of the model sample with color unchanged identified the rock as a dolomitic limestone containing detritic quartz, loamy minerals — illite and montmorylonite, and chlorites. The rock samples of changed color demonstrated an identical phase composition, which means that the change in color was not caused by the emergence of new crystallic phases or the decay of existing ones. Changes were observed concerning the planar mapping of the said elements. The presence of Ca, O, Mg was more or less constant, but significant differences were noted for Al and Si, mostly demonstrating cumulation or decline in concentration in near-surface layers. This phenomenon is related to the cumulation or raising of the loamy substance. A higher content of Fe was noted in all samples compared to a fresh, coloristically unchanged sample. The cumulation of iron compounds, but without forming the crystal phase, is also to be observed in the thin sections. Moreover, the diameter of pores in near-surface layers of the changed samples was found to have grown smaller, from approximately 150 microns to 60–65 microns in effect of the cumulation of migrating substances.

The confirmed cumulation of non-crystal iron compounds in near-surface layers is surely one of the elements affecting color changes in the rock. Further causes are to be found in the sphere of organic changes resulting from the penetration of organic resins (plant gums) into rock capillaries under the influence of, for example, raised temperatures. So far this has been confirmed on one sample of rock with changed color examined by the FTIR instrumental method of analysis.

No bat droppings were noted on the surface of the examined samples.

PAINTING LAYERS ANALYSIS

Pigments and binders in the painting layers were analyzed by the following microchemical and instrumental analysis methods:

– qualitative analysis of elements by energy-dispersive roentgen microanalysis using a SEM–EDS electron microprobe;

– analysis of organic binders by FTIR spectroscopy and gas chromatography coupled with mass spectroscopy GC–MS;

– mineral composition analysis using an XRD roentgen diffractometer; microchemical methods were based on microscope observation of water smears in transmitted light (max. 600x), acid sensitivity (3mHCl, st.HNO_3) and base sensitivity (4mNaOH), and microcrystalloscopic reaction characteristic of selected ions (Ca^{2+}, SiO^{32-}, Fe^{3+}, Fe^{2+}, S^{2-}).

Seven samples were taken from below the dado register and one multi-layer sample from the register of blue *hekerons*. The chief objective of the analyses was to identify the parts with brown-black decoration in the Southern Chapel of Amun as either belonging to the painting layer or accidental pollution. The results were compared with those of samples from the Northern Chapel of Amun (the examination was carried out from September 2005 to January 2006), and with samples of black from the Portico of Punt (ongoing research).

All the samples from below the dado are dark brown in color. Microchemical analyses have demonstrated a similar reactivity in all of them and a similar elemental composition. FTIR analysis of two samples showed the presence of organic binders of the plant gum kind. In all samples iron compounds, quartz, loamy minerals and calcium carbonate and/or calcium–magnesium carbonate were observed. Note was made sporadically of grains of black likely to be vegetal black. The predominance of plant gums suggests that the dark zones on the rock below the dado are remnants of the original painting layer of a different color than now observed.

Six layers were distinguished in the sample taken from the band of blue *hekerons*. The objective in this case was to identify the composition (pigments and binders) of the two oldest layers: the first blue-gray one and the second white one. The analyses have yet to be completed.

Identification of painting layers on a stone support requires the application of different techniques of analysis. Stone (dolomitic limestone in this case) is a porous material in which water-management processes are continuously in action, resulting in compounds migrating to the near-surface layers and the surface, to the painting layers. The process is conditioned most frequently by external factors (humidity, temperature, rainfall etc.). The present condition of painting layers is also a factor of other less obvious phenomena, like bat droppings (in the case of one of the samples), repainting and mutual relations between components. These factors as well as many others appearing from the moment the wall painting is executed have an impact on the original composition of the painting layer, encumbering its identification.

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