ARCE/EAP Subproject
Conservation of the Sarcophagus of Ramesses VI

Tomb of Ramesses VI (KV 9)
Valley of the Kings, Luxor

Progress Report for August 2001
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ABSTRACT

During the month of August, the limestone base for the sarcophagus box was finished. All available fragments comprising the floor of the box were cleaned and test assembled. Fragment groups belonging to the sides of the box were also cleaned and assembled. It was possible to mount some of these groups in the central area of the right side of the box, giving an idea of the partial height, the decoration and the manner in which it has been obscured by the blackened resinous coating. The air circulation system installation was completed with the construction of a stone support for the fan and motor and a box to enclose it as well as covering the flexible pipe outside the tomb with insulating material to protect it from the sun.

I. **Introduction**

During the month of August 2001, work continued on the construction of the level base to support the reconstructed sarcophagus box. This was followed by laying out and joining the fragments of the box, beginning with its floor, followed by the sides and foot end. The installation of the air circulation system also was completed during this period.

Again thanks are due to the Supreme Council of Antiquities for permits and assistance, including Secretary General Dr. Gaballa Ali Gaballa, Sabri Abdel- Azziz Qader, Director General of Upper Egyptian Antiquities, Muhammed el-Bialy, General Director of West Thebes, Ibrahim Suliman, Chief Inspector of the Valley of the Kings and Ahmed Ezz of the West Bank Inspectorate. Thanks, are also due the American Research Center in Egypt and its staff including Dr. Robert Springborg, Director of the Cairo Office, Madame Amira Khattab, Robert K. Vincent Jr. of the Egyptian Antiquities Project and his staff including Michael Jones, Alaa Habachi, Jarek Dobrowalski, Charles Dibble and Cynthia Schartzer.

II. **Completion of the Limestone Base**

After the application of a sand / lime mortar bedding layer and the mortaring in of the forty limestone slabs comprising the base, the surface was sanded smooth. A disk sander was used for this purpose. The hood fashioned of PVC attached to the end of the flexible tubing of the air circulation system was placed close to the sander during this operation. The suction created by the air circulation system was found to be strong enough to catch much of the dust created by the sanding. Temporary protective barriers were set up around the areas of sanding to confine the dust and keep it from being blown onto the decorated walls. After this step the upper edges of the base were sanded to a curved profile. Once the re-assembly of the box has been completed, it will be necessary to sand the surface of the base again to remove marks left by the reconstruction work.

Fig. 1. The completed installation of the support base fashioned from limestone slabs.

III.**<u>Assembly of Sarcophagus Box Floor Fragments</u>**

It was judged essential that the assembly of the sarcophagus box begin with joining together the fragments making up the floor to have an accurate idea of the overall dimensions and to provide a foundation upon which to build up the sides.
The assembly of the floor of the sarcophagus box began with joining together large fragments that make up the head and foot ends (three pieces at each end). This was done by drilling a hole 12 mm. in diameter through the thickness of each of the three fragments for the insertion of stainless-steel dowels 10 mm in diameter. The thickness of the fragments averaged 15 cm. Two large fragments forming the curved head end of the floor, together with another interior fragment, were drilled horizontally for 10 mm. dowels and joined together. The stainless-steel dowels were held in place by being coated with an epoxy adhesive (Araldite). At the foot end, the central fragment and the one forming the left corner were then glued together using epoxy adhesive (Araldite) and a stainless-steel dowel. Three lower edge fragments for the right side were then attached by epoxy to the right foot corner fragment. Other groups of edge fragments from both sides were assembled and joined together into groups by epoxy adhesive (Araldite). While it was possible to make continuous joins of the lower edge on the left side, two missing pieces interrupt the joins of the lower edge of the right side. Fortunately, fragments from the interior were found that served to "bridge" these gaps. As a result, it was possible to assemble connections along the lower edges of the box from the head end to the foot end on both sides of the box. Again, the sand table proved useful in supporting fragments being glued together in a stable position until the adhesive had set.

Once the edges of the floor of the box were laid out, joins for fragments of the interior of the floor were sought and added where possible. As there were fewer visual clues than had been the case with the edge fragments, location of joins was more time-consuming, but eventually it was possible to place nearly all the fragments determined mainly by thickness surface finish, and the appearance of resin stains to belong to the box floor. Two areas in the floor interior were not able o be filled, due to the absence of fragments.

Fig. 2. View of assembly of floor fragments of the sarcophagus box.

IV. **Assembly of Sides of Sarcophagus Box**

Prior to the actual assembly of the sides of the box, it was necessary to separate the fragments into groups of joins and determine exactly where connections with the floor assembly could be made. It had been estimated previously that approximately 75% of the box is preserved in fragments. While this still appears to be true, it is now possible to determine where significant gaps occur. In some areas of the box's sides these absences are critical to the stable assembly process and some means of supporting fragment groups will be necessary that can later be removed should missing pieces later be discovered.

Foot end

Assembly and reconstruction of the foot end is particularly problematic, due to the lack of a significant number of fragments from the central area and the upper edge. There are some groups that form the corners to nearly half the vertical that can be attached, although some gaps exist between joins. The right foot corner fragments have more solid connections and some continuation along the right side.

Fig. 3. The foot end of the sarcophagus box partly reconstructed, with cleaning test.

Right side

Several groups of fragments belonging to the right side of the box were assembled into groups that could be built up from the box floor at this side.

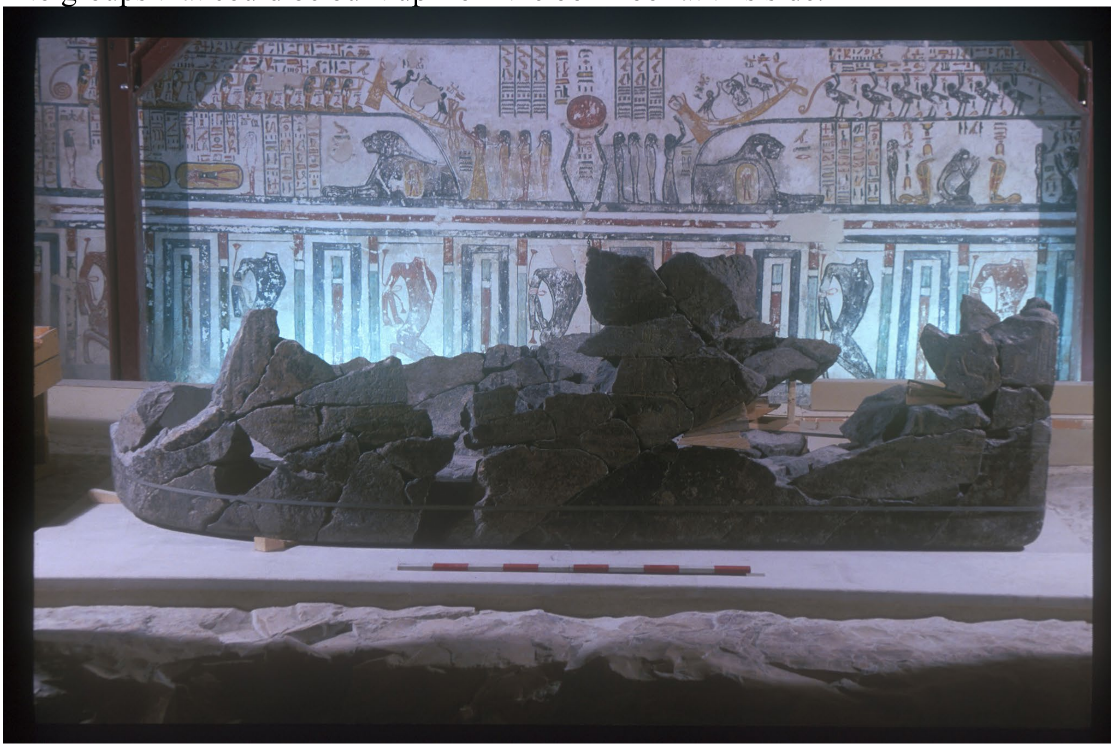


Fig. 4. The right side of the sarcophagus box partly re-constructed.

Left Side
Several fragment groups could be assembled for the left side of the box, including sections from the base to the upper edge. It is possible to assembly the main part of the sides with most of the text columns and much of the scenes below nearly from head to foot end, although parts of the upper edge is missing. These fragment groups now are ready for installation on the central part of the left side of the box floor.

Head End
The curved head end is also a problematic part of this sarcophagus box for reconstruction. There is at least one large fragment (ca. 45 x 65 cm) at the curved right front corner lacking any connection to the base. There is also a sizeable gap in the center of the head end at the base and no complete connection from base to upper edge of fragments belonging to this part of the sarcophagus.

V. **<u>Completion of Installation of Air Circulation System</u>**
The air circulation system installed in July continued to function well while operated on a daily basis. Agreement was reached with the Qurna Inspectorate for the system to be left in the tomb through the completion of the project next year. The possibility was also considered in discussion with EAP Director Robert K. Vincent Jr. for making a long-term loan of the system to the SCA for use in the tomb in the future. The general consensus of SCA officials and staff who examined the system in operation on site was that it was a successful means of evacuating air from the tomb and could serve as a model for similar systems in other tombs as well. Given the possibility that the system would be left in place for some time, it was decided that a more permanent base and shelter for the fan and motor were needed outside the tomb entrance. In addition, it was felt that some protection of the flexible tubing from the effects of strong sun outside the tomb itself was needed. The simplest means of achieving this was to cover the tubing with sheets of foil-backed fiber-glass insulation.

V. 1. Base and Housing for Fan and Motor
A solid base for the fan and motor assembly and the box to shelter it was constructed just to the south of the entrance to the approach ramp leading into the tomb. This location was chosen to allow for a straight run of tubing from the tomb to the fan and then up the hillside above the entry cut for the exhaust. In order to construct the base in this location it was necessary to remove the present information sign supports, consisting of two steel pipes set into lumps of cement poured into holes dig into the debris covering the valley floor. The base was made up of large limestone blocks found in the vicinity of the tomb and the rest area. These were used to construct a platform against the base of the ruble wall running south from the tomb entrance. The blocks were cemented together with a mortar of sand and white cement and then faced with a further cement coating. A wooden base was assembled to support the actual mortar and fan assembly which was then placed on the stone and cement platform. A box shelter was constructed from sheets of plywood/particle board with wood framing. The interior of this box was lined with the same insulation sheets as were used to cover the flexible tubing. The south side of the box was hinged so that it could be opened to allow access to the fan motor for maintenance and repairs. A hole was also cut into this side of the box so that air could be expelled by the motor's cooling fan and a second hole was cut into the west side of this housing for air intake. Two other holes cut into the north side and the top of the box gave access for the

attachment of the flexible tubing to the intake and exhaust ports of the fan. The box was painted with a light tan colored oil paint to protect its surface and so it would better blend into the surroundings

Fig. 5. Painted wooden housing for the exhaust fan with flexible tubing connected.

V. 2. Protection of Flexible Tubing Outside the Tomb

It was felt that some sort of covering was necessary to protect the plastic making up the flexible tubing from the eventual destructive effects of strong sunlight outside of the tomb. Rolls of foil covered fiber glass wool insulation were wrapped around the tubing, foil side out and attached with duct tape and plastic straps. Pairs of these plastic straps were also used to attach the tubing inside the tomb to the wood railing posts along the south side of the walkways in the corridors leading to the burial chamber. These straps are thin plastic strips approximately 50 cm. in length with a rectangular hole at one end and a series of ridges along the other end, which serve to lock into the hole. Similar straps have already been used for the installation of flexible tubing as part of an air circulation system in the tomb of Tutankhamen.

During the work season this summer, it was proposed that a thin layer of limestone chips and dirt, such as covers the sides of the hills in the valley, be placed over the exhaust tubing. However, the SCA Inspectorate officials assigned to supervise the project expressed reluctance to have any further covering placed over the insulated exhaust tubing running from the fan up the hillside. At present the reflective surface draws too much attention to the tubing (as did the blue color off the tubing itself). The idea of covering the tubing with material such as local limestone chips and dirt so that it blends in with the surroundings needs to be pursued with SCA authorities. Since the end of work in the tomb, the SCA has removed the exhaust tubing from the hillside and placed in the entryway. It is recommended that the exhaust tubing be stored in the tomb's first corridor when not in use, until the issue of a more permanent installation on the hillside can be resolved.

Fig. 6. Exhaust fan housing and foil-covered flexible tubing outside KV 9.

VI. APPENDICES

VI. A.
ASSEMBLY AND RESTORATION OF THE PAINTED SARCOPHAGUS OF THE TOMB KV 9.
By Conservator Lotfi K. Hassan

1. Introduction
The conservation project of the sarcophagus of KV 9, composed of hard limestone, was extensively studied with drawings by Edwin C. Brock, who gathered the necessary information concerning the fragments and their joining.
The work began with a layout of all the fragments of the sarcophagus box, a study of the method of assembly and consolidation of the fragments, and the preparation of the structure consolidation phase by insertion of dowels.
Mechanical cleaning phases, using different brushes, scalpels and a small electrical drill. Chemical cleaning, using organic solvents and applying a compress of ammonia and cotton in case of hard incrustation presence.

2. Condition of the fragments
Dirt and wax were attached to the surface of the fragments of the sarcophagus. Large stains of ancient resin extending to both sides of the fragments; the outer side, which is painted and the inner side of the sarcophagus fragments. Also present is a very thin hard incrustation formed by the humidity on the break sides of the fragments.
The colors of the fragments are in bad conditions, due to humidity, the use of the ancient resin, and human intervention.

3. Conservation process

3. 1. Gather pieces
The larger fragments of the sarcophagus were displayed on the platform on the right side of the burial chamber, while the smaller fragments were stored in boxes divided in fragments documented by drawing and other numbered pieces.
The fragments of the lid are currently stored in the area following the burial chamber.
The documented fragments were subsequently spread on the working table, and displayed and joined as documented. As for the unidentified fragments, these were classified according to their thickness and condition of the surface.


3. 2. Cleaning process

3.2.1. Mechanical cleaning

The following technique was applied on the fractures only. As being the initial step of the cleaning, prior to the assembly, it requires scalpels and soft brushes to remove the dust, and a small electric drill to remove the thin hard incrustation.

3.2.2. Chemical cleaning of the fracture

This technique requires the use of acetone and ammonia for the organic deposit, and, as a final phase, washing carefully with alcohol in water.


Fragment of the sarcophagus

Before cleaning *After cleaning*

3.2.3. Cleaning test of the paint

The choice of cleaning materials and methods will depend upon the nature of the substances to be removed and fundamentally upon the resistance of the mural painting. Cleaning operations are never begun without previously identifying the techniques of the painter in order that the materials used in his work are known.

Cleaning operations are invariably begun on less important areas of the painting, leaving the more important ones, and those that are the most delicate, for the final stages.

In the case of Tempera paintings, the porosity of the surface will, of course, depend on the more or less absorbent nature of the ground. Certain continuity is inevitably established between the surface dirt and patina incorporated into the original material.

Therefore, a complete cleaning is only possible if the operation extends beyond the limit where it attacks the original surface. Respect of the original surface will finally be identified with respect to the patina. Two factors now become obvious: firstly, mural paintings, as well as easel paintings, present problems concerning the degree of cleaning to be carried out. Secondly, once the dirt obscuring the legibility of the image has been removed, the problem is no longer one of choosing between a slightly cleaner or a slightly dirtier surface, but one of determining the equilibrium of the whole.

The most of the paint covers by ancient resin with different thickness. The cleaning test was done by testing different organic solvents such as Acetone, Dimethyle formamide, Dimethyl sulfide and Butylamine. The Butylamine has been success to remove the resin carefully. The cleaning test will be completed in the next season.

Cleaning test on fragment

The scenes have been carved in relief on the surface of the stone. Some reliefs have been covered with a thin layer of plaster, while others have been painted directly on the stone without plaster, using the green color of the stone as a background.

There are many different colors used throughout the sarcophagus paint of Ramesses VI – yellow, red, blue and black, with a preference for yellow.

All the yellows used in royal tombs were the local ochre, composed of clay, stained with Iron rust. The royal tombs of the 18th Dynasty witness the fine selection and differentiated decoration of various yellow pigments. Several varieties of yellow pigments were used in ancient Egyptian monuments: yellow ochre (gethite Feo (OH)), jarosite $(NaFe_3(So_4)_2(OH)$, pure orpiment As_2S_3, and ochre blended with orpiment.
Paintings of the tomb of Horemheb No.78 (reigns Thutmosis III and Amenophis II) [Noll (1977)][**] verified the presence of dimorphite, As_4S_3 in a mixture of ochre and other mineral components. This was the first evidence of blending ochre with a high-quality pigment to enhance the glaze and brightness.
Orpiment is not only generously used to decorate the hieroglyphs of the text but also in full painting of the deities on the sarcophagus of Thutmosis III. The paint is covered by a thin layer of a brown resin identified by Jaksch (1985) * as mastic. Orpiment was then found in a pure form without the mastic cover on the sarcophagi of Amenophis II, Thutmosis VI. The pigment was never used in the pure form on wall decorations.
Analysis should be undertaken to verify previous findings and provide additional information on the composition and deterioration of paint layers.
Continued identification of the different samples by x-ray diffraction and x-ray florescence. Analysis of potentially present organic binding media, using Infrared Spectrometry.

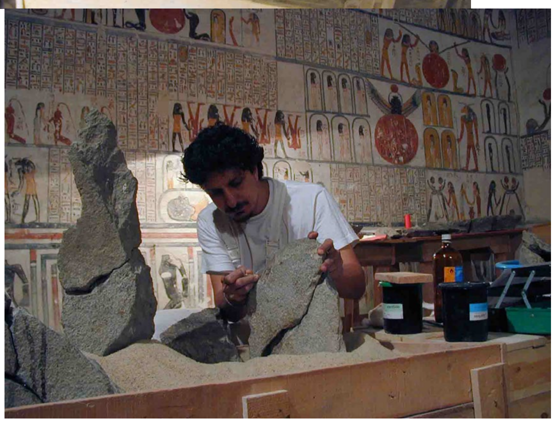
3. 3. Assembly fragments/ join pieces

The assembly of the fragments began with a layout of all the fragments of the sarcophagus box, a study of the method of assembly and consolidation of the fragments, and the preparation of the structure consolidation phase by insertion of dowels.
The fragments have been assembled as groups composed of two, three pieces by using two different epoxy resins (Araldite 106 / Vatico, Egypt with setting time of three hours) and Araldite in tube20ml, England with setting time of five minutes).
The Araldite 106 have been used as a mainly glue and the fast one have been used just as a help to hold the pieces together.

3. 3. 1. Epoxy resin.

An epoxy resin system is made up of two parts – one incorporates the epoxide group, and the other is the hardener, which reacts with the epoxide and Gross – links the molecules.
A wide range of polymers can be produced by changing the epoxide and gross– linking components.
Epoxy adhesives and gap – fillers have high strength and good adhesion to many substrates. The force exerted by a room – temperature setting resin was found to be 4.4 MPa (Elastic modulus).*
Araldite AY 106 resins are frequently too viscous for easy application. Because of their high strength and gap – filling ability, they were used for the consolidation and restoration of stone.

Epoxy adhesives have been widely used and tested (fiorentino & Vlad Borelli 1975).*

Assembly processes

3.3.2. Consolidation

3.3.2.a. Surface consolidation

The consolidation using by acrylic resin dissolved in solvents (Acryloid B72) to fill the tiny space between fragment's flake.

Acrylic

Although in situ polymerization of methyl methacrylate (and other acrylic monomers) has its advocates, the high rigidity and glass transition temperature (Tg) of polymethyl methacrylate are generally considered to make it unsuitable as a stone consolidant.

Specific attention has been given to the use of acrylic resins dissolved in solvents, and the ubiquitous paraloid B72 (Acryloid B72) inevitably makes its appearance.*

Acryloid B72 dissolved in an alkoxysilane such as MTMOS, the reasoning being that the B72 brings adhesive properties that the alkoxysilana lacks.

The B72 is capable of securing pigments or loose flakes.

3.3.2.b Consolidation by inserting stainless steel dowels

The consolidation by inserting stainless steel dowels has been done to consolidate together the fragments, which were necessary for the structure of the sarcophagus.

Epoxy resin (Araldite AY106) using as adhesive to put together the fragments and to glue the dowels.

3. 4. Reconstruction of sarcophagus box

3. 4. 1. Assembly:

The assembly of the fragments began with a lay out of all the fragments of the base of sarcophagus box to study the method of assembly and the preparation of the structure consolidation phase by insertion of dowels.

VI. B

RAMESSES VI PROJECT

FIELD REPORT 2001-2002
Prepared by Dany Roy

The restoration work on the sarcophagi of Ramesses VI (Valley of the Kings -KV9) was carried out from the 10th July to the 23rd August 2001.
Another work session of 6 weeks will be necessary to complete the assembling of the box and the lid of the sarcophagi.
The work plan was divided in five main operations:

1- Construction and installation of wooden platforms
2- Installation of the ventilation system
3- Building of a limestone base (support for the box of the sarcophagi)
4- Sorting, fitting and cleaning of the fragments
5- Assembling of the fragments (gluing and doweling)

1- CONSTRUCTION AND INSTALLATION OF WOODEN PLATFORMS

Wooden structure (platforms and stairs) was necessary both for short and long-term purposes (increasing the surface of the working spaces / providing support for the sarcophagi' s lid).
A re-arrangement of the room was necessary; a lot of fragments belonging to the huge red granite base (cracked in two huge pieces of approximately 8 tons each) located in the middle of the room was in the way of our work. Some 15 fragments (ranging from 30 to 400 kg) were moved and stored together in a space between the wall and one of the granite base fragment (located on the southwest portion of the first bedrock step - 1m higher than the bottom of the pit).
The lid' s fragments (20 pieces ranging from 10 to 500 kg) were stored in the back room of the tomb (being tight in space, our priority was to assemble the box of the sarcophagi before the lid).
A first platform was built resting partially on the floor of the pit (north of the red granit base fragment) and seated on the first northern bed-rock step. This structure measures 2m X 3m and was conceived for permanent use (support the weight of the sacorphagi' s lid; ± one-and-a-half ton).
Two other temporary platforms were built; one over the western part of the pit (1.5m X 2.5m) and one resting on the second southern bedrock step (two meters higher than the bottom of the pit) and the top of the granit base fragment located on the eastern side of the pit (this fragment was stable and in a good position to be used as a support for the platform).
A temporary stairway/ramp was built between the first and the second northern bedrock steps
All temporary elements were built using 2" X 4" planks and steel nails.
The permanent platform was built in a sturdier way using 2" X 4" and 2"X8" planks assembled with screws.
A steel scaffolding was erected on the second northern bedrock step. This structure (2m in height - extendible to 4m, 4m in length and 3m in width) is made of "H-

beams” (12cm in section) carrying a winch on three trolleys (multidirectional system). Lifting capacity; 3 ton with the trolleys and up to 8 tons without the use of the multidirectional system.

2- INSTALLATION OF THE VENTILATION SYSTEM

A ventilation system was necessary in the tomb for the evacuation of the chemicals used in the cleaning process and to expel various dust produced during the work.
The system includes an industrial fan connected to a three horse power motor. 120m of PVC tubing (∅ 8”) was necessary to cover the distance from the burial chamber to the top portion of the entrance of the tomb. The tubes (20m sections in length) were connected together -and on the fan- using PVC-pipes connectors. A PVC hood (75cm X 50cm) was installed in the room.
A temporary support and a box was built for the fan and the motor.
The decision was taken to install the system permanently to expel the foul air produced by the massive number of tourists that will visit the tomb in the future.
A permanent support (base made out of stone and white cement mortar; 1.1m X 1m X .4m) and a wooden box was built (1m X 1m X .90m). This structure is partially concealed by a descriptive sign (that was removed and put back in place after completion of the work).
The tubing was fixed to the stairway ramp using “quick strip” plastic attaches
The tubing located outside of the tomb (40m in length) was covered with insulation paper (aluminum/fiberglass type) to protect the PVC components against the sun and other “natural” elements. The box was also insulated with the same kind of paper to reduce the noise produced by the motor and lower the extreme heat inside the box (created by the reflection of the sun). The two ends of the tubing system were sealed with a wire mesh.

3- BUILDING OF A LIMESTONE BASE

The construction of a limestone base was necessary to provide a clean support for the box of the sarcophagi. This platform is located on the second northern bedrock step and measures 3.2m X 2m.
A first lime-mortar bedding was laid (from 1 to 5cm in thickness) to level the bedrock floor and to create a clean surface to fix the limestone tiles (ordered from Helwan quarry, near Cairo).
Forty limestone tiles were used (40cm X 40cm X 5cm) to cover the lime-mortar bedding surface. The limestone base was after sanded and polished.

4- SORTING, FITTING AND CLEANING OF THE FRAGMENTS

The box and the lid of the sarcophagi are made of a conglomerate stone (green breccia) from the Wadi Hammamat region.
Some 400 fragments need to be sorted, cleaned and glued back together.

Please refer to Lotfi Hassan's report concerning cleaning and assembling methods used for this project.

5- ASSEMBLING OF THE FRAGMENTS (GLUING AND DOWELLING)

So far, about 150 to 200 fragments were fitted and partially assembled (using araldite glue and stainless steel -314 type- dowels).
Priority was given to the box of the sarcophagus for assembling.
Work will be resumed next April, 2002

Dany Roy, August 2001