ter base and the coloured sgraffiti mortar. Medical syringes were used to inject the binding agent. An emulsion of a polyoctane of vinyl was used as the binding agent. The injections caused many problems which had not appeared during similar sgraffiti conservation in Poland. The difficulties were, among others, the result of an untypical sgraffiti technique which used a very thin layer of coloured mortar.

Supplementing losses in sgraffiti mortar

Losses were supplemented by applying fillers. The materials used for this procedure were the same as those used in the sgraffiti i.e. lime binding agent and filler. It was quite difficult to obtain slaked lime [3] for in Norway this material was no longer commonly used in construction. The filler i.e.sand was selected for size of grain and mineral content to match the one used as filler in the original mortar.

Tests were conducted on the strength of the lime bonding and as a result appropriate proportions were determined: 2,5 parts of the filler to 1 part of lime.

In order to achieve the dark tone and colour of the remaining sgraffiti the applied filler was analogous to the original one and all pigments were natural. Before applying them they were checked for resistance to the alkalic properties of lime.

Following many tests the substance for the filler was prepared and its tone (after drying) was close to the colours in the original sgraffiti. Due to different states of preservation the colour tones of the sgraffiti were different in different places and in such cases the colour of the filler was adjusted individually.

First the places where losses in mortar occured were soaked with water and then fillers were applied with the help of a putty krafe. In places where the grey sgraffiti mortar was exposed , the filler was left to dry for about 1 to 1.5 hours and then it was scraped off with a special sgraffiti tool. The surface thus obtained was similar to its immediate environment. In places where both the grey mortar and the engravings were exposed i.e. in places where a reconstruction of the sgraffito was required, the procedure was different. After applying the filler it was evened out to the level of the engobe and the surface was smoothed. It was then left to dry for about half an hour. Milk of lime was then applied in two layers and left to dry for nearly another half an hour. Then the drawing was transfered and the sgraffito engraving was made.

Applying the engobe

The original colour of the sgraffiti was determined on the basis of stratigraphical studies. It was to a considerable extent different than the one following detailed cleaning procedures. The milk of lime was prepared and coloured by natural pigments (umber, ochre, burnt siena, black)thus achieving a colour close to the original one. The engobe was applied with small brushes onto a surface soaked with water in places of „light" i.e. places where the sgraffito engobe appeared. The application required concentration and precision for it was easy to paint over the engraving. Due to this, the process lasted for a long time. In places where the original engobe degraded, a new one was applied in two layers. Difficulties were encountered in places where the engobe was completely destroyed and the sgraffito engraving was very shallow. It was possible to determine with better precision the places where the engobe appeared before its degradation by applying a strong side light to the surface of the sgraffito. Thus the work was conducted at a time when sun rays fell on the sgraffito wall at a sharp angle. It was also useful to install a special theatre reflector.

Inpainting the sgraffiti

The fillers found in the exposed area of the coloured sgraffito moratar i.e. in the area of „shadow" and which had been applied in 1975 underwent a process of considerable darkening. From the technical point of view they were well bound with the base and the original sgraffito, and therefore we decided not to exchange them but to integrate them in terms of colour with the rest of the decoration. They were pointed in a graphic way i.e. with a dot and the tone of the darkened filler was adjusted to the nearest surroundings. An acrylic binding agent in the form of emulsion was used for the pointing. During this process it was established that the pointing which was done during previous conservation did not require serious intervention.

Most of the pointing concerned the top right part of the composition of figure with sword and torch and the top left part of the figure playing the tambourine.

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1. In Poland the sgraffiti decoration on the Scholz House in Legnica contains self-portraits of the authors with the inscription „Giovannini fecit; on the facade of the Czech castle in Lutomyšl there is an inscription: „mister Simon Vlach"; basing on conclusions drawn from analyses of the works found on Polish and Czech territories, many of the sgraffiti decorations are believed to be of Italian origin.

2. The whole enterprise was under the auspices and with the active participation of Arch. Fasting Larsh; Conservation of the sgraffiti was commissioned by Director Bjord Hoyem of Tronderlag Theatre in Trondheim.

3. The materials which were once readily available were exchanged by commercial materials which due to their effectiveness are not questioned or analysed in terms of content. Slaked lime was supplied by BYGGFORSK - Norwegian Building Research Institute, due to the courtesy of the Director, Alf M. Waldum, M.Sc.

Marble Inlay

Conserving the Marble Inlay Work in the Marble Baths of the Karlsaue Palace in Kassel Using Modified Silicic Acid Esters

BY PIOTR SŁUPCZYŃSKI

Thanks to their rich decoration, the Kassel Marble Baths (built in 1722-37 under the Hessian Prince Charles) are one of the true treasures of baroque sculpture and architecture. The visitor is awestruck by the contrast between the modest and highly ordered architectonic division of the building's facade and the richly adorned interior, by the variety of materials used, and by the ingenuity of the architect, who concealed the cupola on an octagonal plane in the simple cubic block of the structure. The Marble Baths were only baths by name; they were actually used as a gallery for Jean-Pierre Monnot's sculptures. The Hessian prince ordered a cycle of classic sculptures and bas-reliefs from Monnot's workshop (Monnot was a Frenchman working in Rome). During a visit to Monnot's workshop, Prince Charles was very impressed by the sculptor's mastery; he ordered the sculptures and commissioned the creation of a building suitable for emphasizing his own prestige.

The Marble Baths, as part of the foundation of the Karlsaue Palace grounds, were built on moist plains by the Fulda River. The water saturation of the building, which is situated on a flood plain, reached a critical point as a result of war damage. During a 1943 air raid, the roof of the building was destroyed; it was not rebuilt until two years later. Heavy moisture accelerated the destruction of the building. The destructive process most notably attacked the marble inlay that covered the walls. The monument was closed in 1981 as a result of the flaking and detaching inlay work, beginning what was to be a nearly 15 year period of tests and experiments. The technological architecture of the object was documented, along with the character and composition of the materials used. Climate and moisture tests were conducted, a series of experiments were carried out and many plans of action were proposed. In 1995, a sample section (approximately 2m [2]) was worked on to serve as a basis for future conservation measures. The methods originally used had to be verified on account of unsatisfactory durability of the applied solutions.

Material and Technique

The building was constructed of sandstone blocks approximately 100 cm thick. The interior of the walls was covered with easily moldable material: volcanic tuff about 8-10 cm thick, appropriately adjusted to facilitate the attachment of marble plates of various thicknesses. The lapillic tuff came from local quarries in Habichtswald [1]. The tuff plates were fastened with limestone mortar or iron anchors to the sandstone material. The marble lining (or, in crystallographic terms, a hard limestone suitable for polishing) was fastened to the substrate in one of two ways:

- approximately 2 cm thick plates of "true" white Carrara Bianco marble were fixed using a thin gypsum mortar (approximately 2-3 cm), which contained 58.25% sulfates and 21.9% carbonates. The Carrara plates were fastened with iron anchors for reinforcement. Sculptures and bas-reliefs were also constructed using Carrara marble.
- coloured marble used as a thin lining [2] about 4-5 mm thick, was fixed using a thermoplastic resin mortar containing rosin and ground marble filler [3]. The contents were determined analytically [4] to be 40% calcium carbonate, 45% quartz and 15% of an organic substance described by microchemical methods as rosin [5]. The presence of trace amounts of saponified elements points to the use of calcium carbonate as ground marble, or chalk as filler. The possibility of the use of calcium hydroxide as an adhesive was excluded. This technique, used widely in Italy, allowed for rapid work without the need for anchoring or stamping, which was especially useful for work in vaults; the dark colorization of the mass also excluded it from utilization with the white Carrara marble.

The following colored marble was used [6]:

a) red marble from the Villmar deposit (Germany),

b) yellow marble – Giallo di Sienna – from quarries in Colle Val d'Elsa near Sienna (Italy),

c) dark grey or black marble from Schupbach near Limburg (Germany),

d) Travertine from the Bad Langensalza area (Germany),

e) green Serpentine Verde Alpi from Piedmont (Italy).

It is very difficult to overlook the high quality and precision in the execution of the work. The individual inlaid pieces fit very snugly without any laxity, resembling the precision of furniture inlay work done with considerably harder material.

The state of the building's preservation and the causes of its destruction

The building's general state of preservation was found to be very poor. There was evidence of many attempts at renovation, which attest to the fact that the building has been in danger for a long time. The deterioration is particularly visible in the base parts of the building, where a large number of the marble plates had been replaced – this is testimony of the high level of moisture in this part of the building.

The damages were divided into two categories: superficial damage, which greatly lowers the visual-aesthetic value of the works of art, and structural, which endangers the existence of the object.

The superficial damages appeared in the form of stone-surface corrosion, surface tarnishing and rust spots on the white marble. The stone's surface, which had originally been polished, had lost its depth and shine – it was now matte and dull. On the surface, a general accumulation of gypsum was noted besides the bound dust [7]. With the help of X-ray diffraction, the presence of calcite and glazenite – $K_3Na(SO_4)_2$ – was also detected [8]. The colored stone had undergone disintegration and structural weakening, especially in the lower sections. The degree of this disintegration depended on the chemical makeup and geological structure of the stone. Crystalline gypsum accumulations were present alongside the streaks, which initially led to the loss of the surface's original shine and to its tarnishing, and then to structural corrosion, which in its last phase caused the plaster to disintegrate. This deterioration process made it necessary to replace many of the colored stone plates. The new plates had also undergone the above mentioned damages. Besides this disintegration, the plates and inlay work also went through a process of detaching from the substrate. Crevices and blisters formed, and the stone finally fell off under gravitational stress. Percussion tests showed that over 90% of the marble inlay surface was not attached to the substrate, and that the inlay remained connected only as a result of the high precision of the work and because of its spreading forces.

The rust spots can be seen on almost all of the original plates of white marble, and they significantly decrease the aesthetic value of the work. The rust is the result of the migration of the iron buckles' corrosion products (the buckles were used to secure the marble plates). The marble's crystalline structure has a high tendency to transport soluble iron salts from the substrate, a result of which is that the smallest

amount of these salts causes spotting on the white marble. Besides the aesthetic problems it creates, the corrosion of the buckles and the increase in corrosion product volume in the form of ferric hydroxide also causes the marble plates or their fragments to become detached.

In this way the tuff plate substrate also underwent advanced destruction. The structure of this impermanent material [9] had been destroyed, which led to its breaking apart into segments and grains. In the base zone, the disintegration reaches about 5 cm in depth, and multi-layered detachment and flaking can be seen along the entire width of the plates.

The causes of the building's weak state of preservation are not only environmental conditions and climactic moisture; the damages also result from the inappropriate use of materials and from improper previous attempts at renovation.

The effect of moisture on the building, which is responsible for the majority of damages, was prompted by many factors[10].

Much of the damage was caused by precipitation. In 1943, the roof of the building was burned in its entirety as a result of an air raid; it wasn't repaired until two years later. Atmospheric precipitation caused excessive moisture to be retained in the upper parts of the building.

A partially faulty drainage system in the cornices caused the water to be sucked inside the walls through fissures and cracks.

The lack of heating and the high humidity led to condensation on the stone elements. The formation of water droplets and their consequent streaking down the colder stone elements took place mostly during the springtime.

An important factor is the presence of moisture from the substrate, which functions on the basis of capillary suction. The building is situated on low-lying fields, which are the flood plain of the Fulda River.

A test of the sandstone's moisture distribution shows that the content of water depends on the elevation of the sample taken [11]. At the lowest point of the building (the bottom of the pool), the sandstone contained 4-4.2% water by weight, which corresponds to 37-39% saturation. On ground level, the weight of water showed to be 2.6-3.2%. At a height of 75 cm, the water weight in the sandstone was 0.7%. Studies of the moisture levels of the tuff were found to be inconclusive because of the lack of a relationship between the elevation (or depth) of the sample taken and its moisture levels [12]. The moisture amounted to 16.4-17.8%, which indicates a saturation of 70-85%; in other words, 70-85% of the pores that were accessible to water were filled. It was surprising to find that even in the places where the marble plates had been long since removed, the humidity was only minimally reduced. This is a result of the tuff's pore structure. Besides the large pores with cross-sections measuring about 1 µm, there exist a large number of micropores with cross-sections under 1 micrometer. In this case, the micropores are responsible for the high hygroscopicity and sorptive capabilities of the tuff in correlation with the relative humidity of the air. The water, which entered the pores as a result of capillary condensation, can be partially removed only by desorption using large energy input (temperature). In natural conditions for the Baths, tests showed little potential for decreasing the moisture of the tuff samples. These possibilities are even more limited by the marble lining. Humidity, both in the form of evaporative moisture and rainfall, can evaporate only through very narrow fissures in the marble inlay, which in practice means a constantly moist substrate.

The mortar that fastened the marble plates and the inlay work lost its cohesion with time and stopped fulfilling its function as a result of its constant contact with the hygroscopic moist tuff. The gypsum mortar on which the white marble plates were placed underwent notable saturation, contaminating the substrate with a large quantity of sulfate ions; on account of their migration through fissures, these ions created efflorescent convexities on the surface. These ions also resulted from unsuccessful attempts at repair, when the detached plates were refastened with the aid of plaster. Cement mortars were also used during repairs. The marked sulfate contamination from these mortars caused further destruction of the object. This was a result of the reaction of Portland cement with gypsum, producing etringite by the reaction [13]:

$$Ca_3(Al_2O_6) + 3(CaSO_4\,2H_2O) + 26H_2O = Ca_6Al_2(SO_4)_3(OH)_{12}\,26H_2O$$

Etringite has a larger volume than its reactants, which causes the corruption of the material structure [14].

Considerable salinity, the migration of salts, large variations in humidity, in effect the crystallization and efflorescence – these are the causes of the monument's destruction.

Another cause worth mentioning is the difference between thermal and hygrostatic expansions in the sandstone, tuff and marble, and the shearing force that results from these expansions [16].

An introduction to the problem of preserving marble inlay work

Since the mid 1980s, attempts have been made at finding the optimal method of conservation of the inlay work; however, the materials that were proposed based on the dispersion of artificial resin cements, hydraulic lime, and even epoxydated resins did not yield adequate results [17].

Tests of the state of preservation and causes of deterioration were performed between 1990 and 1992, and an outline of the conservation plan was consequently drafted. It was decided that the only possibility, from a conservational point of view, was to reinforce the inlay work with injections of a mixture that would not seal the substrate if it retained the appropriate mechanical properties.

In 1991-93, Dr. Schuh conducted tests with the goal of optimizing the silicon acid ester based injection mass. A recipe was finally decided upon: Steinfestiger Wacher OH with a tetraetoxysilane base, a ground marble filler, and an additional phosphate adhesion promoter. Tests were conducted on a rather well-preserved fragment of the interior octagon, and the results obtained were favorable. Before setting to work on conservation in December of 1996, the author called for further optimization of the injection mass, as it didn't adequately secure the heavily damaged parts to the highly disintegrated tuff substrate. It was necessary to reinforce the weakened tuff, and consequently to define a complex, systematic method of strengthening the tuff or mortar, and to ensure the adhesion and cohesion of the injection mass with the aid of materials of various viscosities.

The parameters of the injection mass that were accepted by the conservational committee are as follows [19]:

- appropriate capillary structure, no sealing properties,
- appropriate cohesion properties,
- elasticity and thermal stress transmittability,
- low viscosity allowing for the injection and spread of the reinforced material through the system of cracks and capillaries,
- minimal contraction of the mass.

Table1

sulfate	0.09%
nitrate	0.02%
chloride	0.002%
calcium salts	0.028%
magnesium salts	0.006%
sodium	0.025%
potash salts	0.016%

The presence of soluble salts extracted from the tuff substrate is illustrated by the following table (% weight) [15].

The original mortar contains fine scratches and cracks (0.025-0.1 mm) resembling dried, cracked earth.

Earlier experiments 20 showed that the injection mass with filler was capable of filling fissures with cross-sections larger than 0.5 mm, as particles of the filler are at least 50 micrometers large. The smaller fissures are filled immediately. On the other hand, products with low viscosity such as silicon acid ester based proofers or water dispersions of silicic acid (such as "Syton") can strengthen objects with pore structures of about 50-80 micrometers. In capillaries with larger cross-sections, the solution moves about under the influence of gravity; furthermore, the support of the material is not strong enough due to the fragile character of the resulting silicon structures [21].

Because the mortar we examined contains a system of fissures whose average cross-section is 50 to 300 micrometers, it was necessary to apply a modification of silicon acid esters and its multi-step application with varied fillers. The modification of silicon acid esters can depend on [22]:

- Preliminary condensation: oligomers form, made up of two to 12 particles of monomers with a longer hardening time, a lower quantity of steam pressure, and improved penetration.
- Catalysation and accelerated precipitation of the silica gel: this is used, for example, in fortifying the weak zone near the absorbent substrate. The weakened superficial layer is hardened, and the gel undergoes precipitation in the appropriate place. There is no penetration into the depths of the porous substrate.
- Elastification: by building an elastic segment (i.e. oligomeric dimethylsiloxane) onto the silicon structure being formed, the reinforcement of the stone structure takes place without the simultaneous growth of the elasticity module.
- The utilization of an adhesion promoter, for example from the phosphate group, in order to acquire viscous properties.

The need for strengthening the structure of the highly weathered tuff was also confirmed in the introductory phase. The pore system characteristic of the tuff from the Habichtswald quarry requires that the reinforcing substance be absorbed into the micropores.

Elaboration on the conservational method applied

With regard to the aforementioned variation in the cross-sections of the pores and fissures of the restored materials, Dr. Eberhardt Wendler (Fachlabor fur Konservierungsfragen in der Denkmalpflege, Munich) developed a three step method of applying the strengthening material [23]. The first step was to apply the and highly penetrating tuff proofer with low viscosity. The penetration of the micropores needed a long liquid phase; however, the products available on the market were catalyzed in such a way that the hardening process occurred in capillaries with cross-sections of 10-100 micrometers, without the micropores being filled. In order to ensure an even reinforcement of the superficial layers, it was necessary to simultaneously prevent the drip of the proofer into the depths of the stone. Through the application of ethyl alcohol, the absorption of the proofer and its migration into the deeper layers of stone was reduced. After laboratory tests were conducted, monomeric tetraetoxysilane was chosen, which was catalyzed by a small amount of tinorganic catalyst.

With the aim of strengthening the original mortar structurally, the pores and fissures in the 10-500 micrometer range were filled with an injection mass based on initially condensed silicon acid ester, with the addition of colloidal silica and butyl ester of phosphoric acid as adhesion promoters. The acidic adhesion promoter reacts with the lime substrate to form carbon dioxide, which causes a better division of mass as a result of light foaming.

In the last phase, a mass with filler was applied, which had been periodically applied to scratches and fissures with cross-sections of above 500 micrometers. The filler was a mix of Bolognese chalk and Plastorit 0000 (Naintsch, Austria) [24].

The course of the conservation work on the marble inlay

Conservation work was done on those sections of the inlay work that percussion tests revealed as detached from the substrate. Openings of 1.5 mm in diameter were drilled into the marble plates, and induction nozzles were attached to them with the help of thermoplastic glue [25]. The scratches and fissures were also sealed using thermoplastic glue. The strengthening substances were injected using medical syringes in the above mentioned order, with pauses of about one hour between each phase. Depending on necessity, the detached inlay work was stamped with helical stamps, allowing for fluent regulation of pressure. The stamps were removed after approximately four hours. In the end, the blisters and detachments were completely abolished [26].

Summary

The creation of a system of materials with varying parameters based on modified silicon acid esters allowed for the conservation of a gravely endangered bulding with a complicated technological architecture. This system can also be used in conserving other porous materials.

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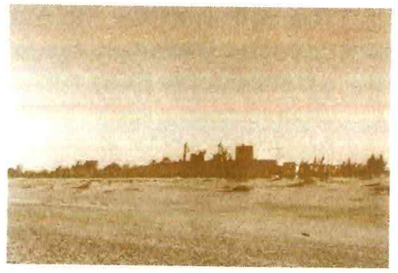
Manuscripts

Early Coptic Manuscripts from an Egyptian Desert Monastery

BY ELIZABETH SOBCZYNSKI



In the autumn of 1996 I received a letter from a Coptic monk of the El'Souriany monastery in the Egyptian desert of Scetis. A year later, Dr Karel Innemee from Leiden University in Holland, Louise Drover and I flew to Cairo. Dr Karel Innemee has been involved in conservation and archaeological excavation in the Middle East for several years. He is at the forefront of a project started in 1991, called the Egyptian-Netherlands Cooperation for Coptic Art Preservation which has as its sole aim the documentation and preservation of the heritage of the Coptic Church in Egypt.

Only very recently a discovery of the ninth century frescos in the ancient church of the Holy Virgin in the Monastery took place and conservation works are being carried out by Eva Parandowska under the auspices of the above project. The ENCCAP project which until now did not include conservation of manuscripts was now prepared to embrace this new responsibility.

However, prior to my visit, Dr Innemee had not been able to obtain permission to see the Library and was hoping that I would be able to persuade Bishop Mattaos to allow me to examine the collection.

Founded in the fifth century, the El'Souriany is one of the oldest Coptic monasteries in the desert of Scetis. The monastery lies between Cairo and Alexandria and until recently was almost totally isolated from the outside world. It has a library which contains unique ancient manuscripts. In the tenth century the archpriest Moses of Nisbis greatly increased the collection by acquiring many volumes and encouraging the monks to engage in scribal activities.

Since the seventeenth century travellers, bibliophiles and thieves have been visiting the monastery with the purpose of obtaining manuscripts and other treasures which has meant that the collection has suffered very considerable damage and loss. Baedeker in 1892 warned all visitors who are in pursuit of ancient treasures; "that there is little chance of finding any more valuable manuscripts here," This, however, is not exactly so.

We were given a warm welcome by Father Martiros, who is in charge of the museum and the conservation of the frescos, and Father Bigoul who is responsible for conservation of manuscripts. Father Bigoul introduced us to his studio, housed in what used to be a cell, situated across a beautiful garden and dominated by the enormous tree of St Ephraim. With an entrance from a long porch it comprised of two small rooms. The door and the narrow windows were fitted with mesh screens to prevent insects from entering. The air was hot and heavy with a smell similar to formaldehyde. There was a sink with running water, a photographic tray, a plastic basin, two small cupboards one serving as a fume cabinet and the other for storage. There were also a couple of tables with surfaces covered in neatly trimmed and arranged sheets of modern paper which were used as blotters, supports etc.a simply constructed light box, a magnifying glass, a scalpel and a few brushes.

On the light box was a page from a sixth century Syriac manuscript which Fr Bigoul was in the process of repairing. The rest of the manuscript was kept in the cupboard to minimise the chemical vapour. To my astonishment Fr Bigoul seemed to be unaffected by the smell.

There were other pages spread on the tables; a ninth century manuscript in Arabic, dark brown with discolouration and very badly damaged edges. As we were looking around one could not help but recognise the the prevailing atmosphere and reverence for the displayed manuscripts.

After four days of waiting, spent with Fr Bigoul assessing local skills, and comparing methods and techniques with western practices, Anba Mattaos granted us an audience. I presented my case explaining that it was imperative to see the collection and make a preliminary assessment as to its conservation and preservation. Permission was granted and we were promised access to the library the next day.

We were all extremely excited by the prospect of seeing and examining the manuscripts. We knew from published accounts that volumes were sometimes found lying in the most unexpected places, torn out pages were in the past used to cover the floor while covers were often rotten, eaten by worms or even simply disposed off. We also knew that since the 1950s the entire monastery had undergone many changes including a construction of a new building next to the Holy Virgin church which was to house the library.

The following morning as we walked upstairs through the narrow, steep stairs cluttered with baskets full of drying onions, chicken pens and hanging white clothes, my heart was beating very quickly with anticipation. We reached the top, passed a small walled landing bathed in sun and entered a room adjoining the library. It was a bookbinding workshop where all contemporary literature, leaflets etc. are produced, and later sold in the souvenir shop next to the church. In front of us were doors completely sealed with tapes. Fr Bigoul slowly removed the tapes and carefully unlocked the lock.

The room was dark with only strands of sun coming through tightly closed shutters. We were however, forced to retreat as a very strong smell of a chemical exuded from the room. It was later explained that this was a result of a fumigation done with phosphine gas, in a tablet form, some two years ago, and the ventilation deliberately restricted in the fear of renewed infestation. Windows and shutters were quickly opened, allowing in a breath of fresh air. Suddenly the room was flooded in an unprecedented amount of beautiful gold light. We put our face masks on and went in again. Modern glass-fronted book cases with firmly shut doors occupied the room. The room was very dusty but tidy. For the last two years there has been electricity in the monastery and as far as I understand candles are no longer used for reading. Few monks are allowed access to the library. There is a specially designated room on the floor below where the librarian receives a request and brings the manuscript.

The collection consists of several hundred mss in Coptic, Syriac, Ethiopic and Arabic on cotton paper, parchment and vellum dating back to the fifth century. They are the source of information about the earliest Christian and monastic life in the Desert of Scetis.

Only a small number of the early manuscripts were illustrated. Even so, the undecorated manuscripts were beautifully executed.

Centuries of mistreatment and bad handling together with the environmental conditions, have contributed greatly to the poor condition of the manuscripts. Paper was suffering from embrittlement, discolouration and mechanical damage. Pages were stuck together and were very distorted. Iron and copper inks have taken their toll, and there are many instances of ink and pigments suffering from transfer, flaking and lifting. Light and UV radiation has weakened the paper, and faded the writing and painting medium.

Silverfish, mice and other insects and pests have added to the damage. Embossed and decorated leather bindings with broken spines have been drying out and crumbling into powder.

Two years ago, Father Bigoul was given the task of improving the condition of the manuscripts. He was instructed to replace old damaged covers and clean and repair the pages. He would first dis-bind the manuscript and laminate every page with a glassine-like paper using PVA/methyl cellulose, 50/50. This increased the volume to about three times the original size. Before resewing, the text block was guillotined removing the natural deckle edge. New edges were created with a newsprint-type of paper, toned with tea.. The adhesive used through out was PVA/methyl cellulose. The new covers were made of leatherette-like material and included a tongue closure to wrap round the foredge from head to tail. It was at that time that Fr Bigoul organised the studio in his cell. With the help of a light box he removes old paper repairs and tapes using a little moisture. Sometimes whole pages are washed and dried between sheets of modern paper. Small holes and losses are repaired with matching toned modern paper using starch paste.

During our stay, we cleaned and dusted the book-cases, all the volumes were externally dusted and a sample surveyed using a tick-box system to assess the overall condition. We also carried out internal examination and dusting with a soft brush to remove sand, insects, loose dirt and debris. We removed pieces of paper impregnated with phosphine inserted between pages. Anything that was particularly friable was