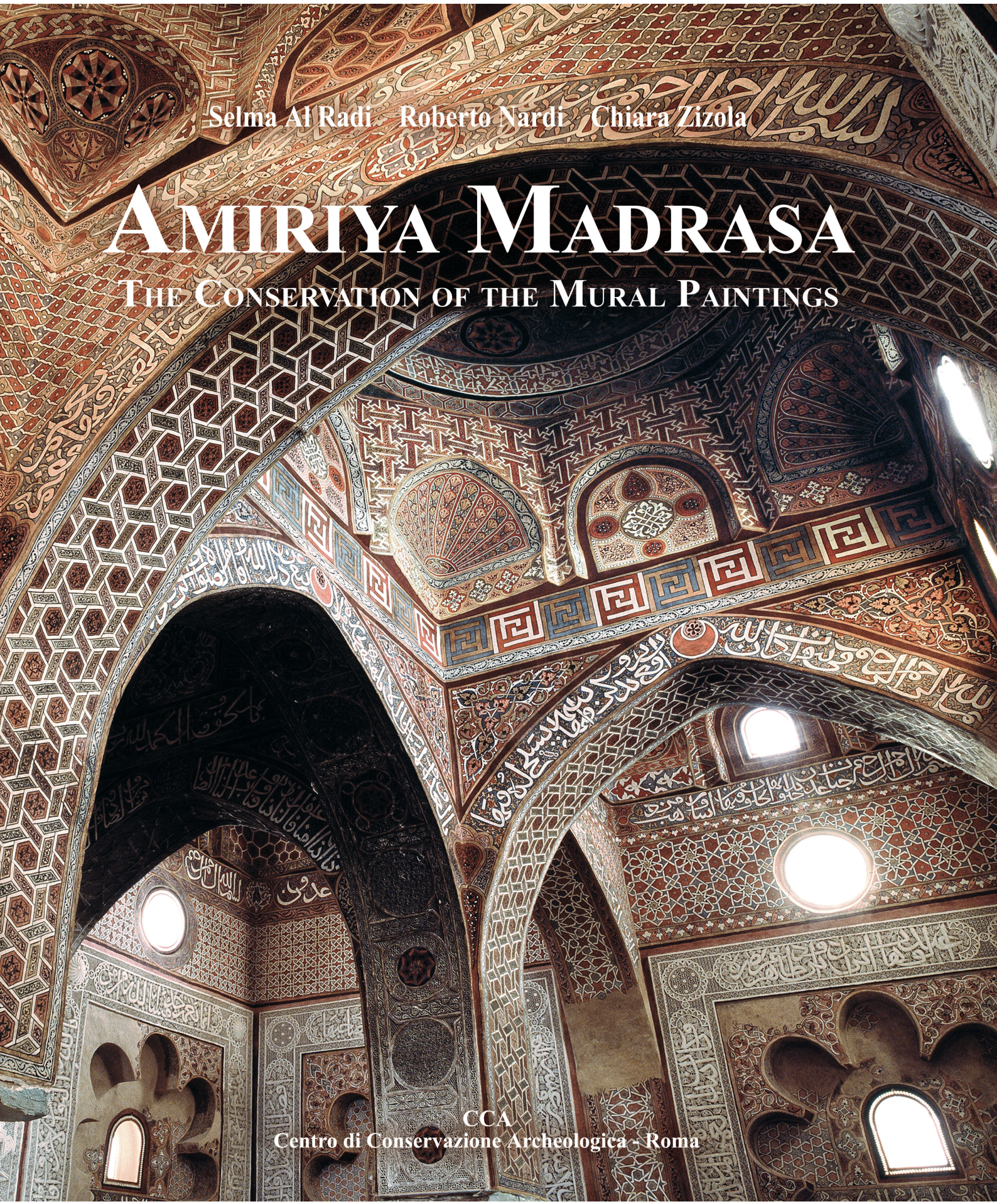
Selma Al Radi Roberto Nardi Chiara Zizola

Amiriya Madrasa

The Conservation of the Mural Paintings



CCA
Centro di Conservazione Archeologica - Roma

AMIRIYA MADRASA

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Selma Al Radi Roberto Nardi Chiara Zizola

This book is published with the support of:
The Italian Ministry of Foreign Affairs
General Directorate for Development Cooperation

CCA
Centro di Conservazione Archeologica - Roma

Editor: C.C.A., Centro di Conservazione Archeologica - Roma
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02020 Belmonte in Sabina
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First edition: May 2005

ISBN 88-901903-1-0

Design: C.C.A., Centro di Conservazione Archeologica - Roma

Photographs::

Archivio Selma Al Radi: (Fig. 1-9; 13-15; 17-18; 22; 64)

C.C.A., Centro di Conservazione Archeologica – Roma:
(Fig. 23a-24a; 27-28; 33; 50-51; 54; 56-61; 63)

Araldo De Luca/Archivio CCA:
(pag. 3; 5; 6; 8; 10; 12; 14; Fig. 10-12; 16; 19-21; 23b-24b; 25-26; 29-32; 35-42; 47-49; 52-53; 55; 62; pag. 111 to 197)

Italian-English translation: Cynthia Rockwell
Italian-Arabic translation chapters 2 and 4: Abrah Malik, Yousif Latif
English-Arabic translation chapters 1 and 3: Khalid al-Razihi
English-Arabic translation presentations, biographies: Maisoon Fatah al-Aswadi
English-Arabic revision: chapters 1 and 3: Christopher Eden

Front cover: Madrasa Amiriya, prayer hall. Photograph by Araldo De Luca, May 2005

Acknowledgements

The program of conservation of the mural paintings of the Madrasa Amiriya is finished: as never before it has been the result of a team work to which many contributed with different skills but, with the same common enthusiasm and determination. We would like to thank many people: without their help all this would have never happen. Thanks to the Yemeni authorities, in particular: Dr. Abdulkarim el-Eryani, Senior Adviser to the President, H.E. Khaled Abdullah Al-Rowaishan, Minister of Culture and Tourism; the sponsors of the project and among them H.E. Abd Al-Karim Al-Arhabi, President of the Social Fund for Development, H.E. Johan F.L. Blankemberg, Ambassador of the Netherlands and the Italian Ministry of Foreign Affairs, General Directorate for Development Cooperation. We thank Dr. Abdallah Bawazir, President of GOAMM and Christopher Eden, administrator of the project, for his relentless assistance. We would like to thank Valeria Mazzacane of the Italian Foreign Ministry who has sustained this project since 1999 and the Ambassador Giacomo Sanfelice di Monteforte who gave the decisive impulse to the Italian participation to the project and, to the funding of this book. Finally we would like to thank all the conservators for the professionalism and the human qualities that have characterized the group during the two and half years of work; among them Elena Macchia and Raffaele Laera who for the whole period of the project have interchanged at the helm of the work on site.

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Dr. Abdulkarim el-Eryani
Senior Adviser to the President

The *Madrasa* al-Amiriyyah, built early in the 16th century by the last of the Tahirid rulers, is indisputably an architectural jewel. Yemeni authorities have long recognized the Amiriyyah's importance, and also the urgency of preserving the country's architectural heritage: when the new Yemen Arab Republic established the General Organization for Antiquities and Libraries in 1969, it chose the Amiriyyah in Rada' and the Ashrafiyyah in Taizz for special attention.

But the actual work of preserving these buildings awaited a fortunate event: the Dutch government funded a program that brought Dr. Selma al-Radi to Sana'a as a consultant to the National Museum in Sana'a. She visited a number of endangered historic monuments throughout the country and helped to undertake preservation efforts in several buildings, including the Ashrafiyyah. But she fell in love with the Amiriyyah, and was soon determined to see this building returned to a sound condition.

Those who know Dr. Selma also know that she is akin to a force of nature. The Amiriyyah restoration has taken more than two decades to complete, the effort hampered in its early years by small budgets, unexpected complications, and rising prices. Selma's enthusiasm for the project overcame these problems, and she was able to instil in donors and Yemeni colleagues the same enthusiasm for the project. Friendships with her many Yemeni colleagues was the cement that held the project together through its lean years. The Qadi Isma'il al-Akwa' (the first president of the General Organization for Antiquities and Libraries) and Yahya al-Nasiri are but two of the many Yemeni supporters of the project who deserve special mention. Yahya al-Nasiri, the Yemeni counterpart to Dr. Selma in the project, was particularly instrumental for his direction of the Yemeni team and for his work in reinventing the recipe for qadad which covers and protects the building.

But the story of the Amiriyyah restoration is not about Dr. Selma and her collaborators. Rather, the Amiriyyah project provides us with a model for preserving the historic monuments of Yemen. The Amiriyyah project is bilateral: its budget comes both from the Yemeni government and from foreign donors; responsibilities in the project are clearly divided between the two sides; and direction of the work is collaborative. A bilateral project requires true collaboration at all levels, from individual to governmental, in order to succeed, and just as importantly it requires enthusiasm and energy of a core group of people. Unless they are restored, literally hundreds of historic buildings in Yemen are facing decay and collapse. These monuments attest to the artistry, visions and sensibilities of Yemeni culture, and should not be left to this fate. The Amiriyyah project shows the way to preserving Yemen's heritage.

H.E. Khalid al-Rowaishan
Minister of Culture and Tourism

In opening the Amiriya we are opening an historic monument closely associated with an important period of our people' history. Yemen has long been the home of a civilization that realized the importance of education in the advancement of nations and of peoples. In Yemen places of worship were connected to science and to civilization, and faith was mixed with science and knowledge, because the intellect is the best path to true knowledge.

This monument, today flourishing in its marvelous appearance, is the best witness to the greatness of the Yemeni people. The Amiriya's unparalleled sophistication of decoration reveals Yemeni creative genius, and the building established for centuries a high standard for excellence in the architectural arts. Yemen has been home to many architecturally distinguished mosques built during the successive periods of Yemeni history. But the Amiriya mosque is a unique jewel that amazes the connoisseur, who recognizes the importance of this monument and strives to preserve it.

The opening of the Amiriya madrasa and mosque will be an important – culturally, religiously, and historically – event recorded among the achievements of Ali Abdallah Saleh, president of the Republic and builder of the new Yemen, who concerned himself with this historic monument during his visit earlier this year and who daily monitors progress of restoration as it moves to a speedy conclusion. Let this monument see the light again, and open its doors for all visitors. Let us not forget to offer our deepest appreciation and thanks to our Italian and Dutch friends who hold Yemeni civilization in high esteem, for these friends contributed with us to the renovation of this marvelous historical monument. And let the Amiriya be a destination of all researchers of history, knowledge and creativity.

H.E. Johan F.L. Blankenberg
Ambassador of the Netherlands

It is with the greatest pleasure that I have accepted the request to write an introduction to this magnificent book on the Amiriya Mosque. Not only does this remarkable monument represent one of Yemen's greatest cultural achievements, but it also stands as a symbol for decades of Yemeni-Dutch co-operation.

The Netherlands has centuries old ties with Arabia Felix, now Yemen. It started when in 1616 a ship of the Netherlands East Indies Company entered the port of Mocha, where soon after a permanent trading post was opened. Its remains can still be seen in the old port town. A quarter century ago a new chapter was started in the friendly relations between Yemen and the Netherlands. A legal framework was set out for development co-operation. Thus the strong and warm relationships which had existed between Yemen and The Netherlands received a new impulse. This event sparked off a renewed interest in Yemen' vast cultural heritage. This interest was epitomised in His Royal Highness Prince Claus, who became a staunch advocate for the preservation of the cultural treasures of Yemen. The late Prince Claus demonstrated his genuine interest on several occasions when visiting Yemen. His ideals live on in the works of the Prince Claus Fund and the many projects he inspired in the past. One of these projects is the restoration of the Amiriya Mosque in Rada'.

In 1982 the Amiriya restoration project was initiated, inter alia with Dutch moral and financial support. It was to take more than twenty years before reaching maturity. During these years several generations of restorers and diplomats were able to witness the resurrection of the Amiriya Mosque. The subsequent generations were each able to see a different step towards the revival of the Mosque in all its ancient glory. In the first phase the restorers set out with the rudimentary task of rebuilding the foundation of the Mosque which was crumbling of old age. The second step entailed a thorough fixing of the woodwork. The third and last step restored the former splendour of the paintings in the domes. Now that the last phase has reached its conclusion and the Amiriya Mosque has been restored to its original beauty, it becomes obvious what has driven the restorers to persist in working on this unique project.

The Amiriya Mosque is a symbol and tribute to those whom worked and supported its restoration. Many hands carried the bricks, wood and the sometimes slow and painstaking efforts towards completion of this undertaking. The very capable patronage of Dr. Selma Radi of the American Institute for Yemeni Studies guided the intensive labour and the continuous relationship between restorers and sponsors of the project. The result of all these efforts is impressive. The restored Amiriya Mosque will, on the one hand, be a monument which the Yemeni people can enjoy and be proud of, enhancing their cultural identity and awareness. On the other hand, the Amiriya will allow foreign visitors to Yemen a glimpse into a culture and history very different from their own. This acquaintance will be a learning experience surely contributing towards a greater dialogue between our worlds.

It is hoped that the resurrection of this great monument will stimulate the Yemenis to continue fighting for the preservation of their unique cultural riches.

I am proud that my country has been given the opportunity to be associated with this magnificent project.

H.E. Giacomo Sanfelice di Monteforte
Ambassador of Italy in Yemen

I am very pleased to have the opportunity to share with readers of this beautiful photographic book some thoughts that I hope are worth emphasis. The *Madrasa* Amiriya in Rada' is an extraordinary monument that has held great historic value since its construction in the beginning of the 16th century, and the restoration work so well achieved during the past two decades has highlighted this value.

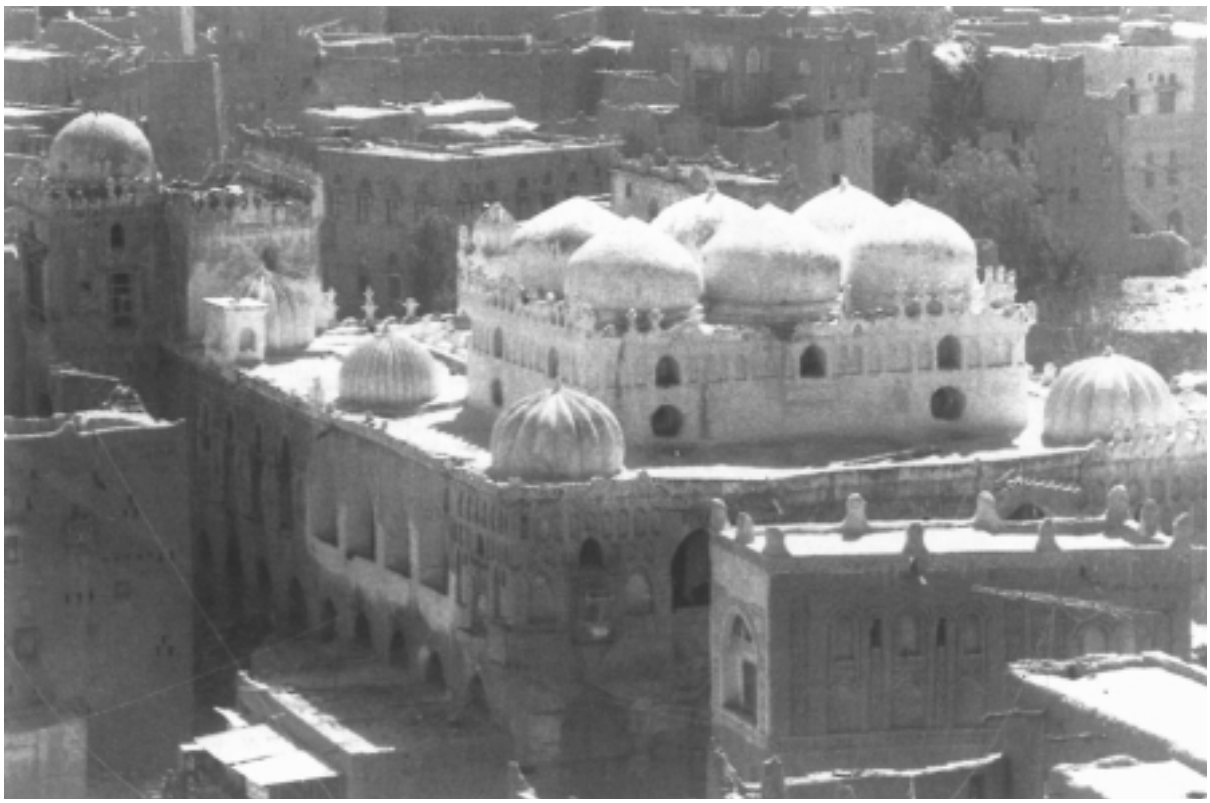
First of all, the architectonic elegance of the *Madrasa* Amiriya and the richness of its polychrome frescoes is immediately obvious to the visitor. I myself, ever since my first visit to Rada'a in 2003, was surprised, and I have been continually struck, by this elegance as the restoration progressed. This restoration was under the expert guidance of Selma Al Radi, and was undertaken by the Italian restoration group from the Centro di Conservazione Archeologica directed by Dr. Roberto Nardi, with the assistance of Yemeni restorers participating in the training project funded by the Italian Co-operation of the Ministry for Foreign Affairs.

I had the privilege to discover, with every visit, new details in the frescoes inside the six domes of the *Madrasa* Amiriya as they were progressively being restored to their original magnificence, until I was able to admire in recent weeks, the totality of their beautiful unique vision that offers to the Yemeni and international public an unparalleled testimony to one of the periods of major artistic splendour of Yemeni history.

In the second place, besides the extraordinary aesthetic and artistic interest that the *Madrasa* Amiriya in Rada' offers to the visitor, its restoration represents a very significant event. The Yemeni Government has undertaken courageous action for enhancement of the considerable cultural heritage of the country, thanks also to the support of foreign partners, among them Italy. I'm quite certain that the success represented by the preservaton of the *Madrasa* Amiriya in Rada' will stimulate Yemeni authorities to continue their commitment in this sector, with the prospect of giving to Yemen a much more widespread knowledge of the country's important cultural resources, and with the aim of developing tourism in the country.

And lasly, the restoration of the *Madrasa* Amiriya is a testimony of the energy of the dialogue and co-operation about the revaluation of the artistic and cultural heritage that Italy started quite some time ago with Yemen. Italy's involvment in this field began with assistance in planning the protection of the old city of Sana'a during the 1980s, and in recent years Italy has funded new projects such as construction of a data-base for the administration of the National Museum in Sana'a (in partnership with the World Bank), the inventory and the restoration of the collection of manuscripts of the Dar al-Maktutat (in collaboration with UNESCO), and also the revival of the Italian Archaeological Mission of ISIAO, with its magnificent results achieved by the excavation and restoration in the ancient cities of Baraqish and Tamna.

For all these reasons the *Madrasa* Amiriya in Rada', so successfully restored, signifies an important outcome for Yemen, for Italy and the other international donators who have contributed to its restoration, and for its future visitors from all the world, who will be able to know and appreciate directly extraordinary beauty.



Chapter 1

THE RESTORATION OF THE AMIRIYA

Selma Al-Radi

The project for the restoration of the 'Amiriya was established after a bilateral joint funding agreement between the Netherlands and the Yemeni governments was signed in Sana'a in April 1982. The Netherlands government, through its Technical Aid Ministry, was quite willing to include the restoration of a cultural and religious landmark as part of its rural development program for the region of Rada'. The bilateral agreement stipulated that the Netherlands' contributions would cover the costs of all the structural repairs of the building, while the General Organization of Antiquities, Museums and Manuscripts (GOAMM) would be responsible for repairs to the roof, and for all external and internal *qudad*; they were also responsible for the cost of housing the project personnel in Rada'.

The Ministry of *Awqaf*, in its capacity as keeper of all religious buildings, agreed to pay the costs of removing and rehousing the squatters living in the ʻAmiriya, and of cleaning of the building. It also paid compensation to the owners of the four shops and three houses built on land adjoining the ʻAmiriya; these structures were demolished to make way for gardens around the ʻAmiriya. Supervision of the project was undertaken by GOAMM through its site representatives.

The Yemeni funds were first made available to the project in March 1983, and the Yemeni contribution, released through the yearly budget of GOAMM, continued until completion of the project in 2005.

During the first 15 years of the project I represented the interests of the Netherlands, and took responsibility for the budget and supervision of the restoration work. These funds also provided for the services of an architect, Jon Bjornson, who worked for the first two years of the project, measuring and drawing the ground plans and elevations of the building. When the original funds were spent and the work had not been completed, Prince Claus of the Netherlands, who happened to be on an official visit to Yemen, encouraged the Ministry to give the project the sum required, and it did. He remained an active sponsor of the project.

After 1985 the ʻAmiriya project was funded as part of the Netherlands Cultural Project in Yemen. The Koninklijk Instituut voor de Tropen (KIT) in Amsterdam were represented by F.C. van Leeuwen who acted as the overall project director. Starting in 1997 the Dutch government made significant additional contributions to the project, administered through the American Institute for Yemeni Studies. These additional funds guaranteed completion of the work. Throughout the project, the interest and the help of officials at the Ministry of Foreign Affairs in The Hague and of the Embassy staff in San'a were constant.

Other contributors to the restoration project were the Agha Khan Award for Architecture, the Anglo-Arab Business Forum in London, and the artist Derek Hill. The only local donation, timber beams, came anonymously.

Although the Netherlands government provided seed money to start the project, and it continued to fund the work until the project's completion, the Yemeni government covered much of the restoration costs. Yemen is considered to be one of the poorer countries in the world, and that reality forced us to try for a more modest budget, and to rethink the processes of restoration. Foreign experts and expertise were expensive, so other methods had to be considered. Whenever possible, a building should be

restored using the same methods employed in its construction, that is, local craftsmen using local techniques and materials. Luckily for us, Yemen still has many traditional craftsmen practicing their old skills, and many buildings being built today are still constructed according to time-honored practices. The logical solution was to use, whenever possible, local talent and materials, having recourse to international talent only when highly specialized professionals were required.

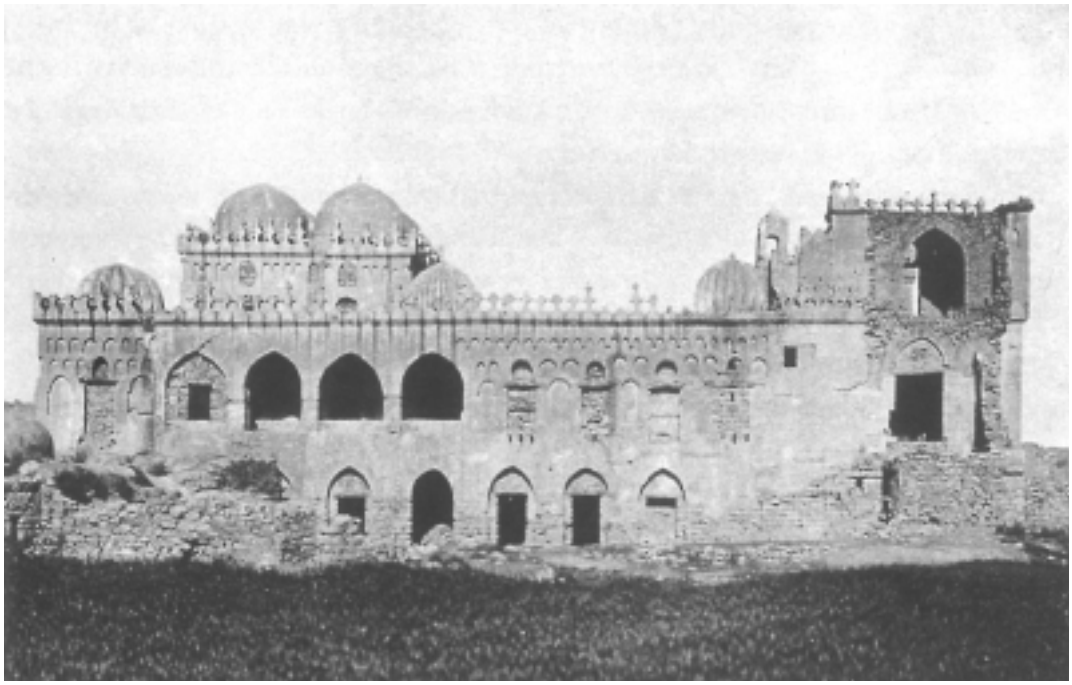
Conservation of the paintings inside the prayer hall required exactly this kind of additional technical expertise. The Dutch donor to the restoration budget agreed to reallocate a portion of its contribution to fund an assessment study of the paintings, which the Centro di Conservazione Archeologica of Rome (CCA), carried out in 1998. The painting conservation project required a separate budget, which the Social Fund for Development and the Dutch government made available. The intervention included a training component in which six Yemeni technicians gained expertise and experience in conserving tempera paintings; a contribution from the Italian Ministry of Foreign Affairs supplemented by a small grant from the United States government supported this aspect of the program. International events delayed the start of CCA's intervention until late in 2003, and the Italian team completed the work in spring 2005. In addition to its contribution to the conservation training, the Italian Ministry of Foreign Affairs also provided funds for the preparation and publication of the present volume. The 'Amiriya project wishes to thank all the above donors for their generosity.

The Amiriya Madrasa

Besides the citadel, the most prominent monument in Rada' is the 'Amiriya (Fig. 1). This *madrasa* or religious school was commissioned by order of Sultan 'Amir ibn 'Abd al-Wahhab, and it carries his name. Ibn al-Dayba' lists it under Sultan Amir's monuments and describes it as a *madrasa 'adhima fi Rada al-'Arsh* or 'a grand madrasa in Rada' al-'Arsh'[1]. The date of the building, *Rabi' al-Awwal* 910 August-September 1504, is carved in stucco on the east wall of the prayer hall. The inscription specifies the date as that of the completion of the building.

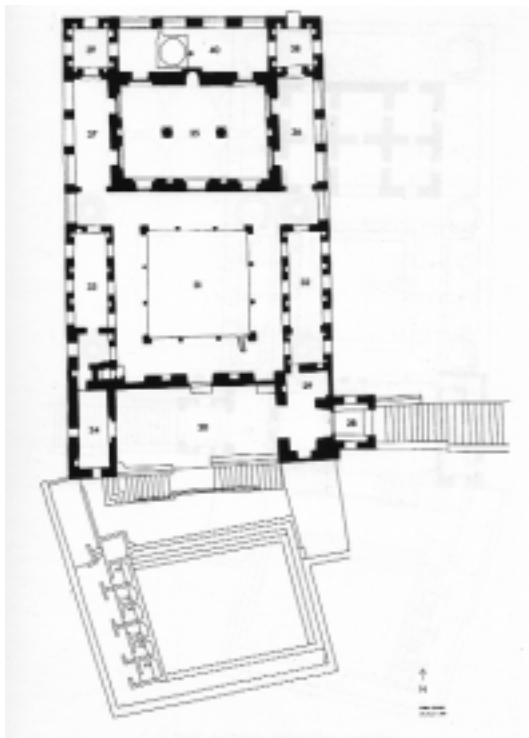
The 'Amiriya is situated below and to the south-east of the Rada' citadel. Today, it stands in the middle of the town, but a photograph taken by Hermann Burchardt in 1900 shows wheat fields planted alongside its west façade (Fig. 2-4)[2], close to a *hammam* or bath-house that existed just to the west of the 'Amiriya. This *hammam* was pulled down in the early 1970's when a road was laid by the local municipality (Fig. 1)[3].

2. Photographs taken by Hermann Burchardt in 1900.



3. Photographs taken by Hermann Burchardt in 1900.

4. Photographs taken by Hermann Burchardt in 1900.

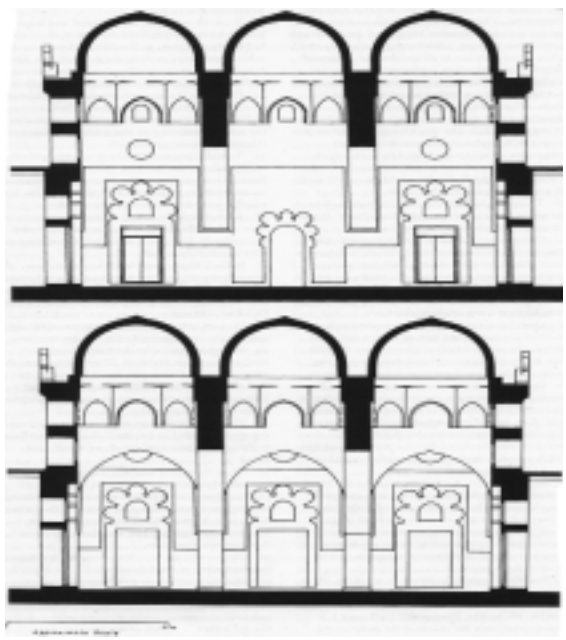


5. The ground floor of the Amiriya.

The ‘Amiriya is in the form of a monumental rectangle that measures 40 metres in length, and 23 metres in width. It rises three storeys in height with a full ground and first floor, and a partial second floor. The ground floor is built of local limestone blocks of differing dimensions, roughly cut and faced on one side, while the first and second floors are constructed of large baked bricks (30 x 22,5 x 12,5 cm) (Fig. 5).

The prayer hall or mosque, situated in the first floor, is a small and beautifully proportioned rectangular room with two central pillars supporting the six domed bays that rise soaring through two floors (Fig. 6). Natural light enters through the round windows of the clerestory, positioned at the level of the roof. The *mihrab* in the northern *qibla* wall is identified by a cinquefoil arched niche upheld by engaged fluted columns; its interior surface is decorated in densely carved stucco, buried under layers of whitewash and overlaid with a modern coat of bright blue paint. The section of the wall immediately behind the mihrab is also decorated in carved stucco.

The upper walls, domes, squinches and soffits of the prayer hall are painted with intricate designs and quotations from the Qur'an, rendered in the most elaborate colours. A wide inscribed stucco band runs along the walls at head height, framing the foliated arches of the doorways and separating the painted areas above from the plain walls below, now painted a vivid blue. The overall impression of the interior of this prayer hall is one of ornate embellishment.



6. The prayer hall or mosque, situated in the first floor.

Traditional building methods and craftsmen

A brief description of the traditional building practices still used by Yemeni craftsmen today is in order before we examine in detail the restoration of the 'Amiriya. Yemen is rich in building materials, and this wealth is reflected in the varied materials used in its different geographical zones.

Generally speaking, the most common building material in the northern and eastern regions is *pisé* or adobe, whereas in the mountainous regions it is limestone or volcanic stone and baked bricks, used singly or combined. Tihama and southern regions use baked bricks to build their houses, and straw for their huts.

Forts, palaces, mosques, and important civic buildings were, and still are, commonly constructed in stone, frequently in combination with baked bricks. Unless a building has a generously endowed budget, the use of stone will usually be restricted to the foundations and walls of the ground level[4]. Rada' is situated on the dividing line between the eastern and highland zones, so it has a hybrid architectural style that mixes stone, baked brick, and adobe, frequently using all three in the same building[5]. Foundations of private and civic structures are usually built of rough-hewn boulders of basalt or of other locally available hard stones. These are laid in foundation trenches that vary in depth, but which are usually dug down until the tip of a pick hits a hard clay or rock level. Meanwhile, the quarried stones are cut, trimmed, and made ready by a *muwaqqis*, or stone-cutter. These cut and faced stones are used only for the outer and inner faces of the wall; the interior space usually has a rubble filling made up of small stones and chips wedged in tightly and bound with mortar. If the *usta* is a real master of his work he will be able to fit the cut stones in such a way (adjusting and trimming them as necessary) that the seams between them will be virtually invisible. Dry-stone walling is also quite common in rural areas of Yemen.

In older houses, the mortar is usually made of a mixture of mud and straw, but in recent times the use of a lime or gypsum mortar has become a more popular way of strengthening the interior of a wall[6]. The latter has been used for monumental and civic buildings from very early periods. As Rada' lies within an earthquake zone, extra wooden beams are integrated into the frame of a building at strategic intervals; these help to stabilize the buildings when tremors occur.

Craftsmen are a privileged group in Yemen, commanding respect and good salaries. Although the crafts are not strictly hereditary, in practice the sons of a stonemason will commonly be apprenticed to their fathers or uncles, and learn the trade from an early age. They begin by learning the simplest menial tasks, such as shaving bricks to fit an arch, and slowly graduate to the more complex jobs. There is a clear hierarchy in the building crafts, and the highest positions held are the skilled master craftsmen or *ustas*, the stonemasons, plasterers, and carpenters. Immediately below them in seniority are

their assistants, who know their master's every need almost before it is articulated. The assistant to a stonemason will not only act as a foreman on a building site but will frequently double as the mortar-mixer, or *mujassis*.

Below him come the stone-cutter (*muwaqqis*) who is paid for piece-work, and the builder, i.e. the stone- or brick-layer (*rassas*); below these are the mixers, the sorters of stones and other semi-skilled laborers. The lowest is the unskilled worker (*shaqi*), who is hired on a daily basis, and who moves around the country in search of work[7].

In all cases, and on every building site, the most senior master stonemason will have seniority over the *ustas* of the other crafts. Whether they be master craftsmen skilled in mud-plastering, a *mumarrij*; in plaster work, a *mujassis*; in *qudad*, a *muqaddid*; or in carpentry, a najjar, it is always the stonemason who decides the order of the jobs and when to begin them. Since many of these jobs are dependent on the seasons - for example, both the roofing and the plastering have to be fitted in between the monsoon seasons - they have to be carefully planned ahead of time, and require the knowledge of a seasoned professional who has experience of all the skills. Only a stonemason deals with all aspects of a traditional building project. He has, in today's parlance, the knowledge and authority of a site engineer, with structural and construction skills combined.

A reputable *usta* will have a team of specialized workers who have worked with him over the years. If he gets a large project and needs more skilled men, he sends for workers whom he knows to join him. Only the unskilled workers will be untried, but if they are found to be adequate they will stay the course of a particular construction project. Although most projects will only need one stonemason *usta*, an ambitious scheme may require more. Then the most senior *usta* will be the principal controller, and the rest will defer to his greater knowledge.

The procedure for building a house is for the patron to choose his *usta* and discuss with him the type of building he wants. A choice is made from the four or five types of house that are in the usual repertoire of traditional builders, and adjustments are made to suit the future owner. The variations lie in the size of the building, while the size of the budget dictates the type of finish and decoration. In a well-endowed and sponsored building, one that has to stand as a testimony of the generosity of the patron, the monumental and financial aspects become very important.

The procedure for restoring a traditional house (a common occurrence with this type of construction) is as follows. The *usta* first removes the outer stones or bricks of the damaged wall, a small section at a time. This is a fairly easy procedure to execute since the facade is not truly bonded to the interior of the wall. He then realigns or replaces the stones, rebuilding a whole section before proceeding to the next one. As each section is completed, a diluted gypsum mixture is poured into it to bind it to the rest of the wall. The same method can also be used for repairing brick buildings[8].

The work-force

The first task for the 'Amiriya project was to search for the best stonemason in the Rada' region. It was truly fortunate that one of the foremost stonemasons, a master craftsman who belonged to one of the most prominent Yemeni families of stonemasons, resided in Rada'. His name was 'Izzi Muhammad Gas'a. The family was originally from Sana'a, but over the centuries had been dispersed across the country as a result of its trade. Imam Ahmad had sent Izzi Gas'a's father to Rada' to build the new governmental headquarters, and he had chosen to remain there. Izzi Gas'a was a venerable and religious old man (already well into his late sixties when he began to work for the project) who wanted the restoration of the 'Amiriya to be the culminating project of his long career. He knew he was ill (probably with tuberculosis), but he was still willing to take on this immense responsibility. Since he was working on a religious building, he cut his wages in half as a donation to the 'Amiriya. We were very lucky to have him as our *usta*. With him came his trusted assistant of thirty-five years, 'Ali Sa'ad, who worked beside him as his gypsum mixer. All the other semi-skilled workers who worked for the project had been part of his team for many years.

Over the years that it took to complete the 'Amiriya, the daily workers came and went, but the hard core remained the same. *Usta* 'Izzi also apprenticed his sons to the 'Amiriya, and the younger ones worked regularly for us during their school holidays. When he died, his son Muhammad, the only member of the family to rank as an *usta*, took over the work and completed the project in his father's name.

The workforce for the structural restoration of the 'Amiriya rarely exceeded twenty-five people. The *usta* had his personal team of five workers plus his assistant, 'Ali Sa'ad. Depending on the work, the unskilled laborers who fetched and carried numbered from five to fifteen. The qudad workforce was separate, and consisted of a maximum of thirty workers who trained and worked under the supervision of their *usta*, Muhammad Sultan or his brother 'Abdallah. When the mud-plastering, the *mirja*, had to be done, *usta* Ahmad Mujahir, his assistant, and four or five laborers did the work. At most, and if all the different skills were in action at the same time, the 'Amiriya employed fifty to sixty workers.

Local conditions in Rada'

The relationship between the project and the people of Rada' was not always an easy one. We were dealing with an archaic bureaucratic system, a tribal municipality that did not really function properly, and some of the most unruly tribes in Yemen. The people of the town criticized the project and complained about it to the authorities. They grudgingly began to take an interest in the work when they saw that it was progressing successfully. They had an immense admiration for *usta* 'Izzi Gas'a and frequently came to

watch him at work; however, this respect did not stop them from offering him their expert advice whenever they could. He was very patient with them all. I think we provided the town with the ultimate in live entertainment. This was especially true for those who lived and worked in the vicinity of the ‘Amiriya. They spent a good deal of time watching us, for there was little else to do during the day; at night they watched television, newly arrived with the electricity. Even the local crackpots were keen observers of our progress, especially the one who tried frequently to burn down the ‘Amiriya.

Time and historical events have not been kind to the ‘Amiriya. The *waqf* for the upkeep of the building had been stolen in the 16th century. There was no budget for its upkeep; it was neglected and not repaired. Squatters and the poor lived in it, and they ransacked the rooms on the ground floor.

Within recent times, the town’s shopkeepers rented the ground-floor rooms to store their stocks, which speeded up the disintegration of the building. By the time the project started the Amiriya was already in an advanced state of decay.

Preliminary clean-up

Work began in November 1982 with the general clean-up of the area around the outside and the inside of the Amiriya. Centuries of dirt and detritus had been accumulated; the depth of the garbage amassed against the east facade measured over three meters in places. The west side was somewhat cleaner, but it too had its share of debris.

After the removal and resettlement of the squatters by the *Awqaf*, workmen emptied the ground-floor rooms and scraped them clean. An assortment of objects was removed from the rooms including bicycle parts, bits of old machines, bales of straw, broken wooden furniture, planks of wood, old and dried-out paint cans, rusted frames, and tons of unrecognizable metal bits and pieces - the flotsam and jetsam of centuries.

On 13 December 1982, while we were still cleaning the building, an earthquake measuring 6.2 on the Richter Scale shook the Dhamar and Rada’ region. Nearly 2.000 people died and thousands of others were made homeless. Entire villages were brought down like houses of cards. But the Amiriya survived with no new visible cracks - a tribute to the old builders who knew how to construct buildings in a seismic zone.

Work officially began with the *usta’s* first order. This was to dig a trench four feet wide alongside the external facades of the west, north, and east walls. The purpose of this trench was first to check the depth and state of the foundations of the building, and secondly to strengthen and repair them wherever it was necessary. When the trench was deep enough, ‘Izzi Gas’a began the work of restoration proper; the date was 19 March 1983.

The condition of the building

The 'Amiriya appeared to be in a very poor physical condition. All its facades showed signs of weakness; they bulged, sagged, buckled, and were cracked in a number of places. This was particularly true wherever the *qudad* had broken, allowing the rain to seep into the interior of the walls. The *qudad* pointing on the stones and the mortar had all but disappeared, leaving the joints exposed. Only the thickness of the walls themselves and the anti-earthquake timber framing seemed to be holding the building up.

The west facade was in the best condition, requiring the least amount of repair, whereas the east face was in the very worst possible state of disrepair. Almost none of the stones in the lower half of the wall were in situ, and the mortar was largely missing. Piers supporting the arched entrances of the ground floor had buckled and been pushed out of their original positions, so much so that there were cantilevered overhangs in certain places. The north facade was in a dangerous condition, and had been since the beginning of this century, to judge by Burchardt's photograph (Fig. 2-4). The central section had detached itself from the main body of the building and was bulging out by almost fifty cm. at the level of the first floor. It was only precariously connected at roof level by the broken roof beams, and by the lowest stone layers of the wall's foundations. One rainy monsoon and it would have come crashing down. It was a very popular place with visiting tribesmen, who sat in its shade after they had finished their shopping in town. Its collapse would have been a tragedy for the town. There was no possibility of repairing this facade in situ. It had to be dismantled and rebuilt from the foundations.

The condition of the interior walls of the ground floor was appalling. Many stones were missing or loose, and most of the mud mortar and wall-plaster was destroyed. The tenants who had rented shops on this floor had dug so deep into the floors, in some places by almost one meter, that they had gone below the lowest stones of the walls - all to make more space for storing their goods.

The mosque remained open for prayers throughout the duration of the restoration project. It was closed only for a brief time when repairs had to be made in the courtyard[9], and again during the last several years of the project when scaffolding erected for the painting conservation occupied the prayer hall.

The first floor required considerable repair. Every arch in the arcade of the courtyard was unsound, and all the ceilings needed to be rebuilt. Walls required partial rebuilding, and many of the bricks had to be replaced. The schoolrooms were in terrible condition. The window shutters had disintegrated, the wall plaster had been eroded by years of leaking roofs, and the floors were weighed down with over two feet of accumulated dirt and debris.

The *muezzin* had been using the 'Amiriya as his second home for many years, frequently staying the night there, and the smoke from his cooking and his candle had blackened the stucco on the walls and the dome. Only the prayer hall was in a structurally

stable condition. A few leaks in the domes and some broken window panels in the clerestory required our immediate attention.

On the second floor roof, the west wing needed minor restoration work, new windows, and a door. This room became the project office. However, the eastern suite required major reconstruction. The domed chamber above the portal had gaping holes in the walls, spandrels, and dome. The shutters were missing, and the forces of nature in combination with nesting pigeons had wreaked havoc in the interior. This entire wing had to be virtually rebuilt.

Most of the roof was unsafe. A majority of the beams were rotten, and the *qudad* had cracked and been repaired innumerable times with cement. This had caused further damage to the roof, as cement does not bind with *qudad*, and causes a separation from the original surface, thus creating newer and bigger cracks. The entire roof area had to be taken apart and reconstituted. The merlons were mostly broken. Luckily, the domes were stable; only the *qudad* needed patching in places.

7. The project's real nightmare was the monumental eastern portal

8. Restoration work began from the outside in.

The project's real nightmare was the monumental eastern portal; that it still stood was a minor miracle (Fig. 7). A major cause for the disintegration of the *qudad* was the tribal habit of firing bullets at the walls. Thousands of bullet holes had punctured the plaster, pock marking the facades and leaving gaping holes through which rainwater could enter. Even mortar shell craters from the many tribal feuds and civil war battles (1961-68) that raged around the town, and in the surrounding heights, had left their mark[10]. These holes contributed to the disintegration of the 'Amiriya; they broke the protective *qudad* skin and allowed percolation, leaking and erosion to damage the walls.

The restoration process

Restoration work began from the outside in. The first priority was the consolidation of the foundations of the ‘Amiriya. This was followed by the conservation of the walls, the exterior facades, the interior walls and rooms, and finally the roof and external decorations.

We were able to check the condition of the foundations by digging a trench alongside the facades and exposing them, and repair them where necessary (Fig. 8). Once that was completed, the trench was filled in and packed with dry stones. Diluted gypsum, *sabba*, was poured into the cracks between the stones so that it bonded to the building. This type of low, bench-like retaining wall is called a *bughla* in Yemen, literally a she-mule, inferring that it carries the load. We built *bughlas* along the west, north, and east sides of the ‘Amiriya. The top course of the *bughla* was made level with the arched doorways, acting like a step in front of the building. It became an extremely popular gathering place with the local tribesmen, who used to deposit their women-folk and shopping bundles there while they went into Rada’ on business.

The restoration of the west side was relatively easy. The east facade was another matter. Rebuilding the lower sections of the arcades and piers was the first thing that had to be tackled. Each stone had to be checked and the loose and eroded ones taken out. The exposed gaps were propped up with stakes, and the overhang was kept in place by wooden wedges (Fig. 9).

9. Rebuilding the lower sections of the arcades and piers was the first thing to be tackled.

The section was then cleaned, the stones replaced in proper alignment, and a thick gypsum mortar was used to strengthen the bond. If the original stones were in good condition they were reused; if not, they were replaced from our stock of stones, collected from the dismantled house and shops. This process was repeated for each pier.

About every foot or so, a small opening was left in the restored section of the wall and a diluted gypsum *sabba* was poured into the wall through a funnel. This solution percolates down between the stones in the wall and solidifies, acting as a binding agent in areas that cannot be reached without dismantling the entire wall. This simple Yemeni technique works extremely well for the roughly coursed, rubble fill masonry commonly used in building monuments and large houses.

By the time the *usta* had completed the work on the east facade, the northern section had been dismantled. It took Izzi Gas'a and his team three months to rebuild the north facade exactly according to its original design. This included replacing all the anti-earthquake timbering, duplicating its previous settings inside the wall. The positioning of these timbers is very important, for they actually tie the wall together. The *usta* placed them above door frames, over windows and arched openings, below the eaves and parapets, and at strategic intervals every ten courses. The timbers were rebated and made to fit into each other, then nailed and placed in a grid-like pattern, somewhat like headers and stretchers, traversing the thickness of the wall.

Lastly, the work on the roof was begun. Roofing is a complex process consisting of four separate procedures. First, the beams are put in place. Then young branches, *qusa*, at least two and a half feet in length, cut from tamarisk trees, *ithil*, are placed across them. These are so densely packed that they completely overlap and cover the spaces between the beams. Thirdly, a mud and straw plaster, *mirja*, is laid and smoothed down over the branches. This acts as a temporary sealing for a roof, and provides an adequate covering - provided it is maintained and replastered at regular intervals. On a monumental building that has to last many centuries a *mirja* plastering is not appropriate, and *qudad* is usually used. But *qudad* is a hard and inflexible material; it cannot be applied to a surface that has not completely settled, or else it will crack.

The drying-out and settling process requires a minimum of six months if it is to be done properly. It must include at least one good rainy season, so that any settling, flaws, and leakages in the roof can be spotted and remedied. This traditional process was carried out on all the roof area of the Amiriya. The north roof was the first to have *qudad* applied to it, and, since we were not certain of the process, a number of mistakes were made. Most of them involved the timing of the consecutive steps and the drying-out process. However, as we experimented with and mastered the technique, we corrected these flaws.

While Izzi Gas'a was occupied working on the external facades of the building, we hired a second *usta,* Abdallah Rizk (a cousin belonging to the same family of stonemasons), to repair the interior spaces of the ground floor.

All the rooms were repaved with the faced stones from the stock amassed by the project. The stones were set in rows into a bed of clean dry soil mixed with small stones, and then leveled. *Qudhran* (a watery solution of gypsum) was poured over the stones and allowed to percolate down the interstices between them. When this mixture sets, it produces a very solid floor. The *hammam* was in fairly good structural condition, only the ceiling had to be repaired and replastered with *mirja*. The time-consuming and labor-intensive work of cleaning-up the shower cubicles took patience for it entailed scrubbing every cm. of the *qudad* with a brush and soapy water. The decorated *qudad* panels were even more difficult and laborious to deal with, because they were covered with many layers of whitewash that had to be carefully scraped off with wooden scalpels. All in all, this work stretched out over a period of two years. When all the repairs were completed on the ground floor, the walls and ceilings of the rooms were whitewashed with lime to provide a clean and finished look.

Built entirely of baked bricks, the first floor appeared at first glance to be in better structural condition than the ground floor, but it too required much repair. The extent of the damage was not obvious until we began to remove the plaster and layers of whitewash from the walls of the galleries and schoolrooms. These walls were liberally patterned with cracks. Once this weakness was discovered, all the rest of the walls had to be scraped off to checked for cracks.

Every arch in the courtyard was cracked, and the bricks were crumbly or broken. In some cases the keystones were missing altogether and had not been replaced - the empty spaces had just been filled in with mud. Over the years the arcade had received so many coats of whitewash that it was probably the only thing holding it up. The arches were checked and repaired with new bricks.

Only nominal repairs were carried out in the prayer hall. The small leaks and holes discovered in the domes were closed, the clerestory windows repaired and new alabaster panes were put in to replace the original ones. Sections of the carved stucco panels were cleaned, and the many layers of whitewash were scraped off to uncover the amazing variety of geometric designs that pattern the walls. The portion of the stucco inscription that deals with the date and dedication of the building was also cleaned to clarify the buried illegible writing. This inscription gives the name of the royal patron and the date of the building.

The stucco panels of the prayer hall are over five cm. thick. Interestingly enough, when these stucco carvings were being cleaned they were found to be full of the desic-

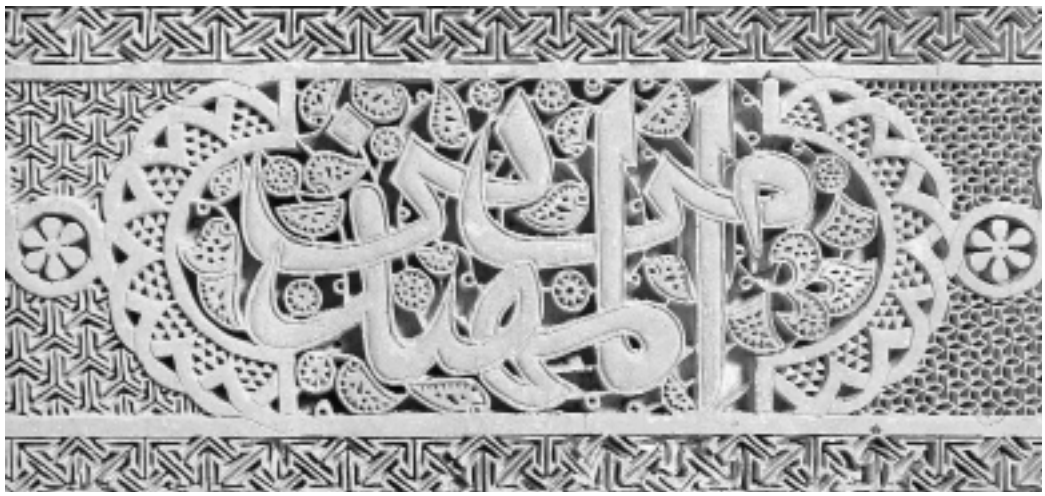
cated remains of small insects. Every carved space and arabesque was crammed with thousands of these larvae. Samples sent to the Museum of Natural History in London, were identified as carpet beetle larvae, a breed that feeds on most substances of animal origin[11].

The repair work on the second floor/roof area was of a monumental nature and entailed the removal of the entire roof area, one section at a time, and rebuilding it. The facades of the clerestory and surfaces of the domes of the prayer hall were checked for cracks and repaired with *qudad*. The dismantling of the roof area and its rebuilding had to be spaced out over a period of three years, since financial constraints and the bi-annual monsoon rains forced us to complete only one section of the roof at a time. If the budget for the project had been available in larger installments, the roof could have been repaired in less time. This would have entailed using many more workmen, but it would have been more economical in the long-run.

As it was, each section was opened individually, the beams were checked and the rotten ones replaced with the new *ilb* beams, the walls were consolidated, and the roof finished in the traditional manner with *qudad*).

The last part of the building to be repaired, and the one in worst possible condition, was the eastern portico (Fig. 7). After a great deal of thought, Izzi Gas'a decided that it should be rebuilt in place, despite the advice of a number of experts who opted for the total dismantling and reconstruction of the portal. This phase had the entire population of Rada' watching in admiration, trepidation, and horror. They were convinced that we were going to be killed when (not if) the portal fell. It did not. It was rebuilt without using any shoring devices, only the mandatory wedges. Izzi Gas'a even gave everyone an extra thrill when he left the keystone of the arch open overnight. He wanted to prove his method true - that wedges, when placed correctly and in the right spots, could carry all the load. He was right; the arch held.

Unfortunately, this was the last major piece of restoration that Izzi Gas'a was able to complete for the Amiriya. He had been suffering, probably from tuberculosis, for a number of years, and died in November 1987. His greatest wish had been to complete the restoration of the Amiriya before he died, and he almost succeeded in achieving it. In fact, the most difficult aspects of the restoration were completed by him. His son Muhammad, an *usta* in his own right, assisted by his two younger brothers, carried on and completed the work. It can, therefore, be said that the restoration of the Amiriya was a Gas'a family endeavor. It will stand as a tribute to a great family of stone-masons.



10. The interior space of the mosque is ornate and heavily decorated with carved stucco decorations.

The carved stucco decoration.

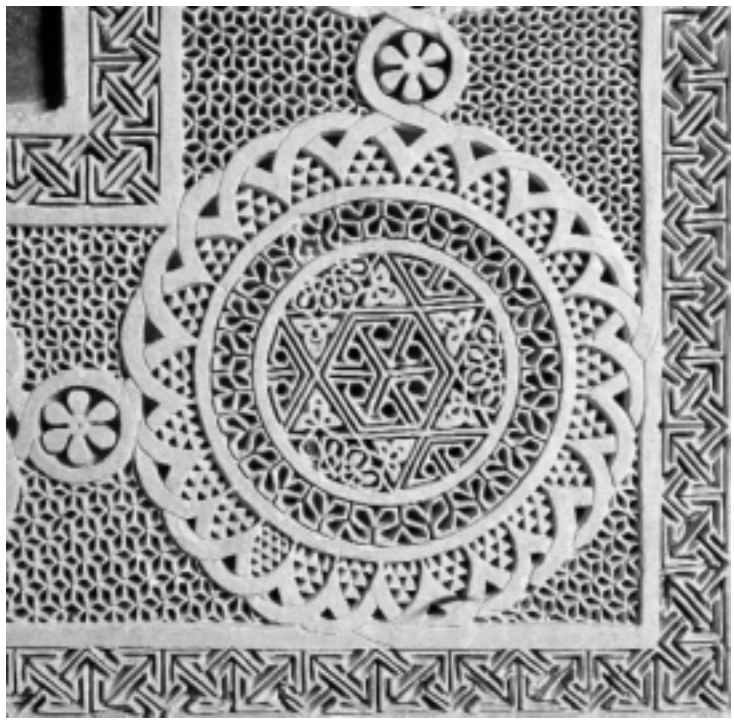
The interior space of the mosque, situated within the 'Amiriya Madrasa in Rada', is ornate and heavily decorated. The domes and upper walls are covered with intricate floral and geometric patterns painted in tempera colors. The lower sections of the walls are decorated with continuous running panels carved with intricate patterns, surrounding the founding inscription (Fig. 10-12). The entire *mihrab* wall is also decorated in carved stucco patterns – a two line stucco inscriptions, separated by a frieze of arches, and crowned with a finial completes the picture. Carved and painted stucco also covers the intrados of the arches on either side of the *mihrab*.

The carved stucco in the prayer hall had been covered over with layer upon layer of lime or gypsum wash. At some point, probably during the 1950's when enamel paints were first introduced into Yemen, lurid colors, green, red and blue were used in thick layers to cover the *mihrab* decorations and the lower parts of the walls (Fig. 13).

These layers, removed during the cleaning process, protected and preserved the stucco in good condition. Had the carved stucco been exposed it would have suffered from people trying to uncover it and it would have been damaged.

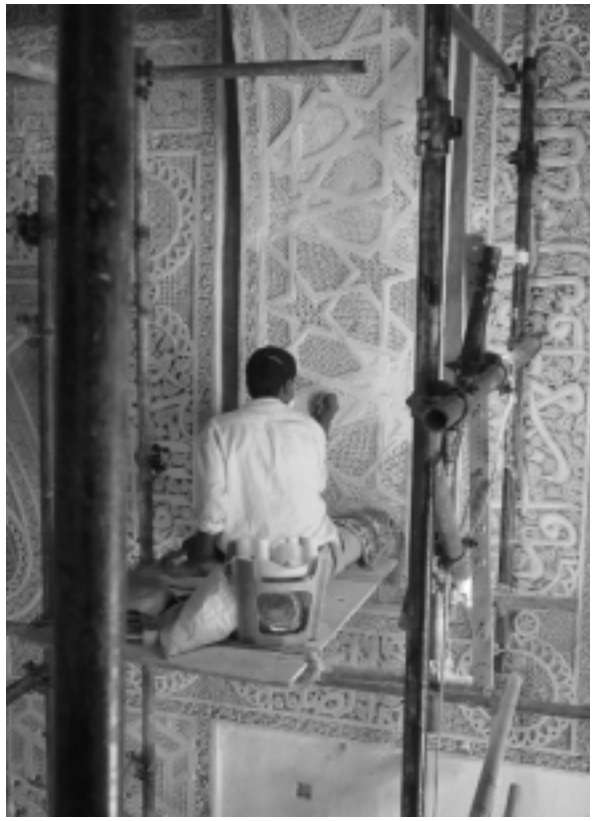
Quranic inscriptions and floral and geometric patterns were the most popular used by the artisans of the Amiriya. The workmanship is very fine and the carving deep. The plaster was applied directly to the walls and carved immediately. This must have been done section by section. A wooden backing under the stucco was only used on the ceiling in the southern corridor to act as a strengthener.

11. The lower sections of the walls are decorated with continuous running panels carved with intricate patterns, surrounding the founding inscription.



12. Detail of the stucco decoration.

It has taken nearly fifteen years of work (by the author and an apprentice) to completely remove the layers of whitewash and uncover the carved stucco in the prayer hall. This task has now been completed and the designs and patterns can now be seen clearly in all their splendor (Fig. 13-16).



13-14. It has taken nearly fifteen years of work to completely remove the layers of whitewash and uncover the carved stucco in the prayer hall

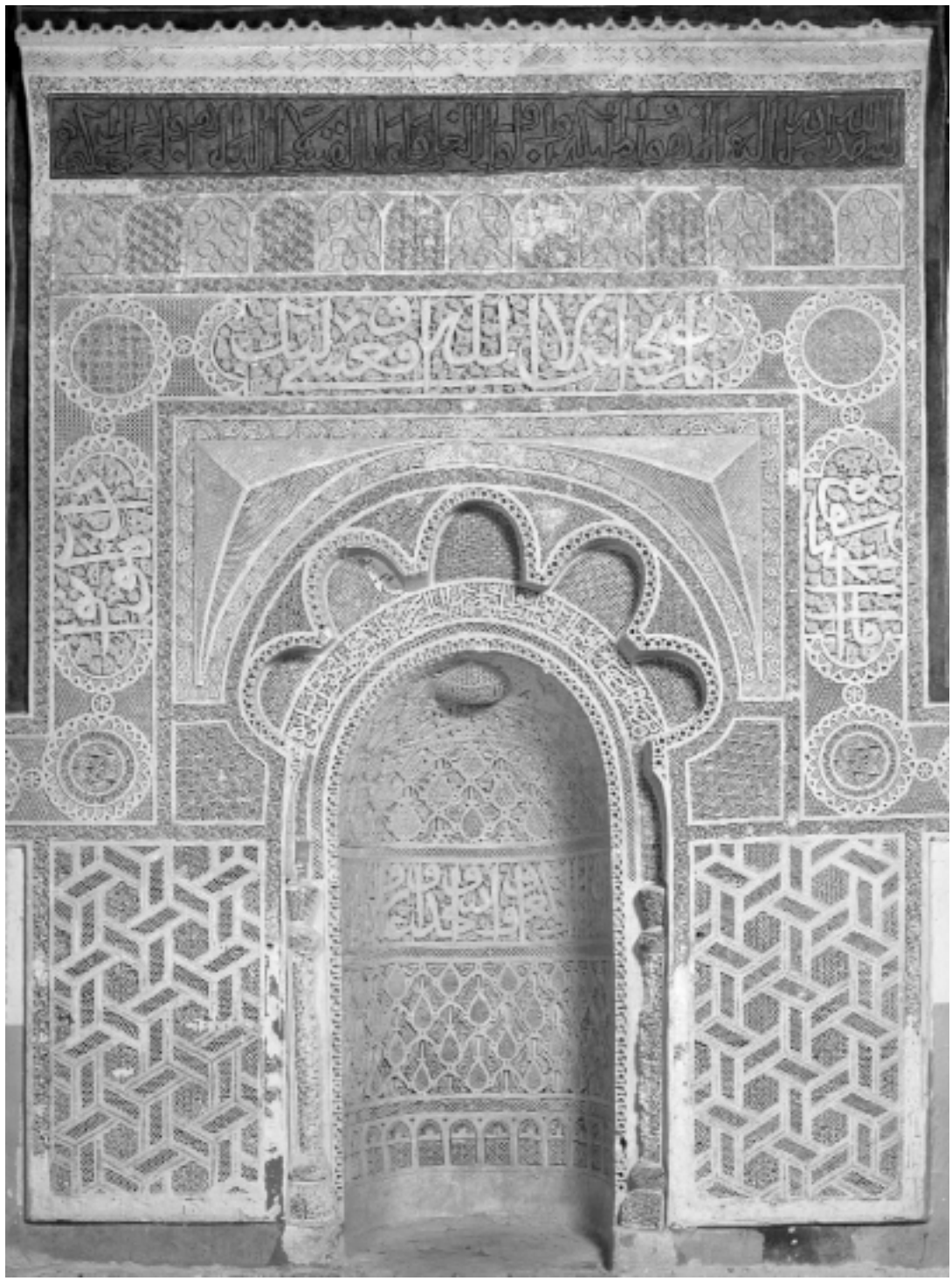
Intricately carved stucco patterns also cover the drums and the ribbed domes of the southern gallery as well as the two small domed rooms at either end of the northern gallery. These domes were in fairly good condition and only needed minimum cleaning. However, the ceiling in the northern gallery was in very poor condition and largely detached. It had to be completely dismantled, repaired and consolidated, and then reassembled in its original position. This was successfully done.

15. Lurid colors, green, red and blue were used in thick layers to cover the mihrab *decorations*

Qudad

Qudad is an ancient water-proofing plaster that protects walls, roofs, and other external features. *Qudad* can be used only on stone or brick constructions; it does not adhere to mud-brick, cement blocks, or concrete[12]. *Qudad* has been in use for millennia in the Arabian Peninsula, and in Yemen, in particular, where it probably originated. The earliest preserved example is found covering the sluices of the ancient dam at Marib[13]. A similar plaster is found in other countries, including the Indian subcontinent, where it was also used as a protective coating on the exterior facades of buildings[14]. By the 17th century it had spread from Yemen, Oman, and India to the East African coast, probably brought by merchants and traders[15].

Qudad is an expensive, labor-intensive, and time-consuming process that simply cannot be hurried. When cement was introduced in Yemen some twenty-five years ago, it was eagerly taken up by builders who wanted to build quickly and cheaply. *Qudad* was put aside, and most stonemasons adopted cement in their new buildings. So, when we began restoration projects in the early 1980s, only a few of the older masons remembered how *qudad* was made. However, their memories were not precise as to the exact quantities required for each ingredient. Experimentation was necessary before it was possible to determine the exact ratio of each of the ingredients and the time required for each step of the process. The Amiriya project revived this traditional method, assu-



16. The Mirab *after the cleaning of the stucco.*

ring its survival for the future by training workers in the due process of its application. The *qudad* technique is now alive and flourishing once again[16].

Qudad is made up of two basic ingredients, *nura* or lime, and an aggregate like fine sand or small riverine pebbles mixed together into a mortar. In Rada', as well as in other volcanic regions of Yemen, *hushash*, or volcanic cinders, are used instead of pebbles; this apparently makes the final product more durable.

Qudad is made in the following way:

1. Good quality lime, freshly fired, must be obtained[17]. It is slaked in water for a period of at least two weeks. During this time the lime should be turned frequently and the water topped up - it must not be allowed to dry out. The slaking must be prolonged for fine finishes such as carved moldings or panels, sometimes for up to two or three months, or until it reaches the consistency of a sticky dough.

2. While the lime is being slaked, the surface to be covered with *qudad* has to be prepared. A roof surface takes time to prepare. The temporary mud-plaster or mirja, which has protected the roofing materials (beams, twigs, etc. until they have settled, has to be partially removed, and small stones, or *midhar*, embedded in it. Just before the roof (or wall surface) is ready to receive the *qudad*, it has to be doused with water and dampened. If it is a wall facade, then the surface has to be cleaned free of any dust, and the bricks and/or stones washed down and articulated so that the first layer of *qudad* can adhere, and penetrate into the crevices.

17. Pebbles and sand are mixed together in a ratio of two parts of aggregate to one part of lime. They are then blended together with water and pounded with a long shovel or wooden paddle.

3. The aggregate to be used - pebbles, sand, or cinders - must be cleaned and washed down to remove dust particles, which will otherwise weaken the mixture. The two ingredients are mixed together in a ratio of two parts of aggregate to one part of lime. They are then blended together with water and pounded with a long shovel or wooden paddle (Fig. 17). The required consistency is achieved when the particulate matter - the aggregate - in the mixture has reached a size pertinent to the layer in which it belongs.

4. For the lowest layer, the mixture has to be coarse and rough, with the particles as large as corn kernels, so that it can adhere better to the prepared surface. The middle layers require a smoother mix so more lime is added to the mixture and the ratio changed to half lime and half aggregate. The topmost level requires further adjustment: the ratio has to be changed to one part of aggregate to two parts of lime, and pounded to a fine paste.

5. The first layer of *qudad* should be about five cm. thick. It is applied and worked between the pebbles, into the cracks and interstices of the surface below, until it begins to adhere properly. This is done with the help of a sharp-edged stone, a riverine pebble that has to be slightly larger than a fist, which is repeatedly banged down on the mixture. This pounding process has to be done for at least three or four days; only then can the next layer can be applied. The task is boring and easy on a horizontal surface like a roof, but when the surface is vertical the procedure is much more complicated. The *qudad* has to be literally thrown at the wall facade and then quickly worked into the crevices between the bricks or stones; it falls off as fast as it is thrown and has to be reapplied again and again. It is only by dint of continuous application and pounding that the *qudad* eventually begins to adhere to the surface of the wall.

6. Each layer has to be worked and pounded for at least three or four days until it adheres and becomes one with the layer below. The *qudad* has to be kept moist - it must never be allowed to dry out. A watery lime solution is the best agent for keeping it moist; a bucket of this mixture has to be permanently on hand.

7. Three or four layers of *qudad* have to be applied to a surface that is exposed; facades in an interior courtyard or *hammam* need less. Whereas five cm. of *qudad* is adequate for an interior wall, a minimum thickness of 10 cm. is necessary to protect an external facade. A roof surface or merlons require at least 12 to 15 cm. of protective *qudad* coating.

8. Once the right thickness has been achieved and the *qudad* layers have been securely damped down and smoothed, the next stage can begin. This consists of polishing,

or rather burnishing, the surface with a smooth, rounded, riverine pebble until it attains a hard, almost marble-like quality. Burnishing requires the use of the full weight of the hand, pressing the pebble down and. moving it in either a circular or an up and down rhythmic fashion (Fig. 18). Again the *qudad* has to be kept moist at all times with a watery lime-wash; this can be sprinkled on the *qudad* with a small broom. Burnishing is the most important step of the *qudad* work. The work is painstakingly monotonous but perseverance is essential. Morning and evening shifts have to be organized lest hairline cracks appear on the surface. Each evening when work stops care must be taken to wet the qudad so that it stays moist until the next morning's shift - this is essential for the first four or five days. After that, the *qudad* can be polished twice a day. This twice-daily polishing must be kept up for a period of three or four days, at least. Burnishing then decreases to once a day, then once every two days. This frequency has to be maintained for at least two to three weeks. The physical appearance of the *qudad* must be scrutinized carefully every day for cracks. If even the faintest of hairline cracks appears, polishing has to be prolonged. In fact, polishing and burnishing can stop only when no cracks can be seen, and when the surface develops the appearance and sheen of marble. The time for the burnishing phase must be judged by the usta on site; it cannot take less than a month, and six weeks is a more likely estimate.

18. Polishing, or rather burnishing the surface of qudad with a smooth, rounded, riverine pebble produces an almost marble-like quality material

9. The *qudad* is then left to dry, a process that can take up to two months, depending on the season[18]. It has to be checked regularly in case cracks appear; if they do, then burnishing has to be resumed. If no cracks appear during this drying out period, then the last stage can be carried out.

10. The final process consists of applying a coat of animal fat, usually beef fat (preferably marrow), on the finished surface. The fat is melted down and smeared on the surface of the *qudad* with a bit of sheepskin; it is an extremely smelly and unpleasant process. This fatty coating provides a temporary, water-proof seal that prevents the fresh qudad from flaking off during the monsoon rains. After that it can take care of itself.

11. *Qudad* can take up to a full year properly and finally to set. It becomes progressively harder with age, and with care and periodic maintenance it can last for centuries[19]. *Qudad* is a very labor-intensive and costly process - to complete a section measuring roughly six by sixteen feet requires a minimum of nine unskilled laborers and two skilled craftsmen working for up to two months. Two workers are needed to prepare the mixture, which has to be turned constantly and moistened, four workers to fetch and carry (water, *qudad*, stones, lime, etc.), and three or four others to pound continuously, smooth, polish and burnish the surface.

The 'Amiriya and Ashrafiya restoration projects conducted numerous experiments with *qudad*, changing the formulas of the mixtures and the ratios of the ingredient until the exact mix was reached for each use[20]. For example, it took a number of trials to figure out the right consistency of the *qudad* for the first and top layers. A cruder mixture proved to be best for the former, and a finer and smoother one for the latter The slaking time for lime is also crucial; two to three weeks was found to be sufficient for normal work, but two to three months was the optimum for the stucco carving layer, whose *qudad* has to be of a sticky consistency. Although the correct ratio of the ingredients and its consistency are important, the most essential aspect of this craft is the polishing of the *qudad* to the right hardness. The longer one polishes and burnishes, the stronger, it becomes - that is the secret of good qudad. This cannot be stated strongly enough - if one skimps on the work of this phase, the qudad is weakened and will begin to flake off and peel in a very short time. That is the most important thing we discovered in working with qudad. It is the extra polishing that converts it into the seamless, rock-like consistency for which it is justly famous. *Qudad* is a man-made material that successfully imitates a natural one, i.e., limestone. Whereas limestone takes hundreds of thousands of years to form, *qudad* takes only a year or two at most. It is one of man's most ingenious inventions, and worth the time and cost.

Conclusion

Yemen is a country that is blessed with a rich cultural heritage, with many architectural monuments and archaeological sites. Most of these monuments require minor or major restoration work - an expensive business. How can developing countries with limited resources like Yemen finance the preservation of their cultural patrimony? One possible method is the one that was adopted for the restoration of the Amiriya - the use, as much as possible, of local resources and turning to international talent only when highly specialized professional were required such as the preservation of wall paintings.

Local craftsmen are well versed in the traditional building techniques and materials of their own culture, and these can be adapted for restoration. The knowledge of traditional methods and materials and their usage is still alive, if not flourishing, in most developing countries. Even if they have been forgotten, they can be reconstructed and revived. After all, the building materials of the old world are limited, and the knowledge of how to use them is available somewhere. Every country should make an effort to document their traditional crafts so that they can be transmitted to the next generation of craftsmen. These crafts should not be allowed to disappear. Modern technology and methodology can be used to make these crafts easier to reproduce, and less labor-intensive and time-consuming.

The physical restoration of the building was completed in 1987; the Amiriya is now structurally sound. The *qudad* work continued till the end of the project. The carved stucco today is cleaned. The carpentry and woodwork - that is, the making of the new windows, *mashrabiyas*, and doors - has also been completed. And the conservation of the wall paintings in the prayer hall has also been completed[21].

As planned many years ago the Amiriya has been completed in time for its 500th birthday. We hope it will survive for another 500 years and more.

NOTES

[1] Ibn al-Dayba' 1988, p. 470.

[2] I wish to thank the Staatliche Museen Preussischer Kulturbesitz of the Museum fur Volkerkunde in Berlin for their courtesy in allowing me to publish these photographs. The Museum kindly had them copied for me from Burchardt's original negatives in their collection. The photographs were apparently taken on two separate visits to Rada', in 1900 and again in 1910. This can be easily deduced from the photographs of the north side; the earlier one shows adobe rooms built up against the north wall of the 'Amiriya, while the later one does not.

[3] al-Akwa' 1986, p.337; Porter 1982, pl.26.

[4] The best description and photographs of the varied regional architecture, and the different building systems in Yemen, can be found in Varanda 1982.

[5] See Varanda (1982, pp.254-8 for photographs and plans of houses in Rada'.

[6] See Varanda 1982, pp.100-6 for stone, and pp.108-11 for mud and brick architecture.

[7] See Varanda 1982, pp.100-1, 106 for photographs of stone-cutting and building, p.109 for building in mud, pp.102-3 and pp. 112-13 for plastering and roofing.

[8] I have seen the collapsed facade of a four-storeyed house in Rada' rebuilt while people continued to reside in it; and in the old city of San'a I observed a stonemason replacing the stones of the ground-floor walls of a five-storeyed house while life went on normally inside.

[9] This was a policy advocated by the project to placate those who were accustomed to perform their daily prayers in the 'Amiriya. Although this caused difficulties for both parties (we had to be extra careful while working and they continuously had to sweep up after us), the problems were outweighed by the good-will it generated. It definitely counted as a bonus point in favor of the project.

[10] Local tradition has it that after a tribal truce has been negotiated the parties involved have to fire bullets at the 'Amiriya, somewhat like an expiation ceremony. I witnessed many tribal negotiations in the courtyard of the 'Amiriya but never a shooting session. Although the 'Amiriya is not considered to be a *hijra*, or safe place, in recent times it seems to have been designated as such by the local warring tribes of Murad and Gayfa.

[11] Larvae of Anthremus, carpet beetle (Coleoptem: Dermestidae]. The Museum could not be more precise in its identification because all the specimens were larvae and not 'adult beetles, preferably alive'. They apparently live in all woolen materials and carpets and 'thrive best in places where they are undisturbed'. The depths of the carved stucco would have been a perfect breeding ground for them. When fully grown they presumably descended and ate up the carpets that are a feature of any prayer hall. The sheer number of larvae per square inch implies an infestation of plague proportions. Perhaps that was why such a thick, blanket white-wash was initially smeared over the stucco. See Carpet Beetles, British Museum (Natural History), Economic Leaflet, No.8.

[12] Al-Radi 1994, pp.6-12

[13] See Yemen, p.65, for a photograph of the Marib dam with *qudad* still in place. The dam was rebuilt many times; the latest phase is dated to the 5th century AD. The *qudad* is probably from that late phase, though some of the lower sections may be earlier. *Qudad* is preserved on many pre-Islamic dams and cisterns and numerous Islamic monuments in Yemen.

[14] See Merklinger 1981, figs 24-5, 27-8, 35, 38, 41, for the exterior facades of mosques, *madrasas*, mausoleums and other monuments in the Deccan, in Bidar, Holkonda, Bijapur and Gulbarga. I looked closely into the cracks of the *qudad* on the Gol Gunbad in Bijapur, and it seemed very similar to Yemeni variety.

[15] *Qudad* can be seen on forts, mosques and large private houses dating from the 17th-19th centuries in Mombasa, Lamu, in Zanzibar old town, and in other sizeable towns along the coast of East Africa. It makes a particularly efficacious protective coating in that wet and hot climate, keeping the walls dry.

[16] Credit for the successful revival of *qudad* must go to 'Izzi Muhammad Muslih and Yahya al-Nasiri. They worked hard with the memories of the *ustas*, experimenting and trying to reconstruct the most accurate procedures.

[17] 'Izzi Muhammad Muslih designed and built an on-site kiln for the ‘Amiriya. We bought raw lime from a local quarry and fired it ourselves; that way we were able to guarantee its freshness. In the long run this proved to be more economical.

[18] In Yemen, *qudad*-work has to be done between the two monsoon seasons, that is, between March/April and August/September. The best time is during the long, dry season that lasts from October to March.

[19] We had to break up the fragments of the old *qudad* of the 'Amiriya roof with a sledge hammer.

[20] The San'a preservation project has continued the work on *qudad*, as has the Canadian expedition to Zabid; see Lane 1988 pp.18-20; Keall 1988, pp.28-33.

Chapter 2
THE CONSERVATION OF THE MURAL PAINTINGS AND THE TRAINING COURSE

Roberto Nardi

Introduction

The Amiriya *Madrasa* of Radà was the focus of a vast restoration project that began in the 1980s, bringing this building of great historical interest and architectural-artistic quality to new life after the state of neglect and destruction in which it had languished. Today, it lives again in the splendor of its architecture and the colors of its paintings.

Thanks to the iron determination of Prof. Selma Al Radi, who found generous and tireless funders such as the governments of Yemen, The Netherlands and, recently Italy, the architecture and paintings that had paid such an enormous price in terms of deterioration can now once again offer visitors the enjoyment of their magnificence.

Not only did Selma Al Radi marshall the forces necessary to complete the Amiriya project, but she was also able to carry off this operation of great scope and difficulty without ever losing sight of the essential principles of high-quality restoration: sensitivity to and respect for the materials and original forms. Moreover, the local resources and traditional know-how were recovered and enhanced.

The objectives of this project were to restore the architectural structures, reclaim the surrounding urban context, create a museum and return the building to its role as a place of worship. Further objectives were to insert the Amiriya *Madrasa* into a tourist circuit that would attract the valuable economic resources represented by so-called "cultural tourism", restoration of the complex cycle of wall paintings, and the training of a group of six local operators in maintenance of the wall paintings.

This volume focuses on these last two programs: restoration of the wall paintings of the Amiriya *Madrasa* and the professional training course for six employees of the GOAMM. The programs were carried out by the CCA, Centro di Conservazione Archeologica of Rome, and have now come to an end after more than five years all told, including planning and execution of the work.

As is our usual practice, we will attempt here to draw up a balance sheet of what occurred during the conservation program, so that the great amount of experience accumulated over this period can be shared and used by scholars and colleagues.

We will attempt to retrace the major steps in a rather complex and lengthy operation, looking back critically at the organizational, managerial and administrative aspects (in this chapter), at the historico-artistic ones (chapters by Selma Al Radi and Chiara Zizola), and the more strictly technical features (chapter by Chiara Zizola).

After ten years of work in Rome in monumental restoration (Roman Forum, Capitoline Museum, Crypta Balbi), the CCA, Centro di Conservazione Archeologica, in 1990 turned its attention especially to sites and monuments in the Middle East, developing a specialization within a professional sphere that in itself is already specialized.

Treatments of monuments of great fragility and size, carried out with special techniques and materials, involving major resources in remote countries with varied organizational systems, in places that differ in culture, language and religion – all these factors provide a challenge on top of the inherent difficulties of a highly specialized professional field. Such difficulties have an impact on every level of the project: from planning to logistics, from organization to management, from administration to monitoring, from technical execution to daily life.

For these reasons, it is extremely important, at the end of such a project, to report the experience without any censorship, so that the positive experiences can be shared and one can learn valuable lessons from the negative ones. In this way, the events that appeared to have generated snags and problems in the regular performance of the work can be useful in the future.

Progetto Amiriya began for the CCA in 1998, when it was asked to draw up an executive plan for the restoration of the paintings. During a two-week visit, Chiara Zizola and Roberto Nardi traveled to the site to inspect the monument. The effect was immediate and overwhelming. The architecture and paintings had hit their mark: it was clear from the very first moment that we could not resist this adventure and that the CCA would carry out the restoration.

The magnificence of the forms, the original splendor of the paintings and their serious state of deterioration, the absolute and urgent need for treatment, the risk of losing everything – these were formidable arguments to convince us not to withdraw but to allow ourselves to become so involved in the conservation program as to be willing to invest more than two years of the entire resources of the group in *progetto Amiriya*.

Organizational matters were built on the following structure, which made it possible to carry out a project of such complexity – full of technical challenges but also rich in satisfaction: the resident director of the American Institute for Yemeni Studies (AIYS) of Sana'a, Christopher Eden, acted as program administrator, Selma Al Radi continued as overall project director, and the CCA "Centro di Conservazione Archeologica" of Rome assumed the technical responsibility for the treatment. Today, at the end of these long years of cooperation and teamwork, and comforted by the result of having brought the project to a happy conclusion, we can definitely make a positive judgment about the formula adopted for the direction, management and administration of the program. It is a happy duty to thank our colleagues and friends Selma Al Radi and Christopher Eden for their invaluable work and the prompt support always given to the Amiriya project.

The project

In tracing a chronological account of the treatment, it would seem perhaps obvious to begin by describing the planning phases of the project. Yet, it is necessary to stress that this is hardly such an obvious procedure: in our professional field, performing a conservation treatment following an executive project is still a rather unusual practice, outside the norm. For this reason we must acknowledge Selma Al Radi's immediate availability to budget for this operation. Moreover, a description of the executive phases might also be useful in continuing to give concrete examples for future use.

From a technical standpoint, the drafting of the project employed two professionals on site for two weeks, followed by six weeks in the studio to analyse and process the data gathered, to perform laboratory analyses of the color samples and original materials, and to write the final document. In the course of the two-week inspection, the painted surfaces were analysed, the conservation condition was documented, and treatment tests were carried out.

This allowed us to verify the monument's reaction to the operations performed, the type and amount of materials needed, the time required for the work; to analyse local conditions and organize the logistical measures necessary for a regular work flow; to estimate times and costs; and to evaluate the administrative burden of the initiative.

Analysis of the painted surfaces

This operation was performed visually, directly *in situ*, using mobile scaffolding and lamps; traces of the original executive technique and of the conservation condition were surveyed, recorded on base maps and studied.

Documentation

The information gathered during the visual analysis was collected in graphic plates divided by theme. This procedure allowed us to study and understand how some historical events had been stratified on the surfaces, the current condition of the surfaces and the decay mechanisms. Only when all of this seemed clear was it possible to plan the technical details of the treatment and set up measures for future protection. The documentation also served as a benchmark from which to depart in recording what was accomplished during the treatment, a sort of personal chart to be updated during future maintenance of the surfaces. The list of the characteristics identified for drawing the documentation maps is as follows[1]: old restorations, dust deposits and lime incrustations, detachments of the plaster and paint, blistering of the paint film, losses of plaster and paint, carbonate deposits, decohesion of the paint layer, erosion of the paint layer, exfoliation, cracks and breaks, guano deposits, *lacunae*, mechanical trauma, salt efflorescence, scratches, water infiltration. The graphic documentation was accompanied by photographs taken with traditional 35 mm film.

Treatment tests

To be defined in detail, operations of cleaning, extraction of soluble salts and consolidation call for technical trials to be done on site under real working conditions. Therefore, during the first inspection we tested the procedures for cleaning, in-depth and superficial consolidation, removal of soluble salts and treatment of lacunae.

Having the opportunity to perform technical treatment tests on the paintings also allowed us to clearly delineate some of the methodological principles that would inform the entire conservation treatment. It is worth listing the main ones, because as a whole they explain the operational choices followed in the course of the intervention:

- minimum intervention;
- conservation in situ (no detachment of paintings);
- reversibility of materials used;
- compatibility of treatment materials and techniques with the original ones;
- clear recognition of treated areas when viewed up close;
- flexibility in adapting techniques and programs to unexpected events;
- thorough documentation of treatments;
- complete transparency regarding choices and operations and full diffusion of the results of the treatment.

The results of this work of data collection, analysis and testing were crossed with information about the site where the treatment would occur, local logistics, climatic data, requirements for use of the building in view of its religious character, and any other information available in 1998, leading to a single document: *the project*.

The document also contains an estimate of the time and expense of the work, a proposed schedule and all the logistical information involved in order to carry out the work properly. This document was discussed with Selma Al Radi and – once approved by the Department of Antiquities of Yemen – was used on the one hand as a means to produce a contract for assigning tasks and, on the other hand, as a fund-raising tool to find the resources needed for the program.

Today, at the end of the treatment, we return once again to read over the project in order to see with a critical eye what was accomplished in the reality of this delicate and complex worksite, in a location as challenging as Radà. Correspondences and projectual errors will be studied in order to learn also from unexpected events or from those carried out differently than originally planned.

Executive planning and logistics

One of the most attractive aspects of the conservation profession is that one rarely encounters repetitive problems in the conservation and restoration of monuments: put simply, every monument is different from the others and requires specific solutions.

Therefore, the technical responses to problems must also be different. Certainly, there are general categories linked, for example, to the constituent materials of the works; and these categories come into play in the course of a restorer's professional training. Thus, one becomes a restorer of paintings or stone or metals, and so forth. Obviously, given the delicate nature of the works and the complexity of the treatments required, one never finishes learning and deepening one's knowledge in any particular field of specialization.

All this is well known when one contemplates a highly specialized profession such as that of the conservator. Less well known is the fact that within the same category of constituent materials, there can be such differences as to make it impossible to standardize the planning of treatments. With tempera wall paintings, such differences are linked to the typology of the artifact and the architecture, their state of decay, the dimensions of the painted surfaces to be restored and the geographical location of the monument.

The first difference in planning is determined by numbers: a program for restoring 60 m^2 is not the same in difficulty (and consequent technical choices) as that of a program for restoring 6 m^2 multiplied by 10. They are quite different things – not so much for the technical operations in themselves (which involve executive differences, among other things) as for the implications on the level of organization, logistics and management that are involved in a large worksite with many people working at once.

The second difference is found when the treatment takes place in remote countries, remote both geographically and in culture and habits. In such cases, a number of factors can have an impact on the success or failure of the program: travel, housing and daily life of personnel, safety; provision of materials and equipment, adaptation of local materials and infrastructures to the project, adaptation of the personnel to local materials and infrastructures, the organization of the worksite, and interaction with local personnel.

When the work takes place in a remote spot, situated in a small town in Yemen, one must add other factors to the above: language difficulties, cultural and religious differences, the ambiance and conditions of local life, the distance from the capital, Sana'a.

Bearing all these things in mind, and returning to the project results at hand, one must consider that the paintings of the Amiriya Madrasa cover 600 m^2 of surface – a huge size even at home – with very high technical difficulties, which had to be tackled and resolved at Radà, a small town situated in a plain between the mountains, with a standard of living very different from that we are used to at home. Perhaps this will give an idea of what this project involved in terms of organization and management.

Therefore, we would like, on the one hand, to stress the satisfaction of having accomplished a conservation treatment with such characteristics; while mentioning, on the other hand, some of the technical and organizational aspects in which we invested such energy and which we believe were the winning strategy that made possible the results discussed here. And they are being discussed so that such experiences might be helpful in the future to anyone dealing with conservation projects with similar characteristics.

These technical and organizational aspects involve, for example, the personnel employed, preparation of the treatment, the calendar of the work campaigns, the supply of materials, the worksite organization, accommodations for the personnel, and security.

Personnel

It might seem banal to place the "personal factor" – i.e. the professionals employed in the project – at the top of the list of the person who plans and manages the program. Yet, it is precisely the organization and management of this aspect that influences the quality of the results, the welfare of the group and the overall success of the operation.

Unlike organizing a conservation project "at home", where the professional profile of the restorer is most important, the aspects that must be considered in choosing a group of professionals to work in a location such as Radà are broader and even verge on more personal character traits. Apart from known technico-professional qualities, the conservator must also guarantee: reliability and ability to interact within a group; capacity to adapt to "unusual" conditions and deal with the unexpected; an open mind and cultural curiosity toward a radically different environment than one's own; and, at the same time, great tact and respect toward the local population.

The work and daily life in a project such as the Amiriya of Radà is made up of a continuous interaction with the local inhabitants: from the Yemeni colleagues participating in the training course, the local workers involved in the other Amiriya interventions, the workers responsible for the scaffolding, those who gravitate around the project with other functions (drivers, watchmen, household help), up to the neighbors, everyone else who roams around the Amiriya (authorized or not), and the inhabitants of Radà itself. Living together is only possible when there is total respect for diversity and ability to engage in reciprocal dialogue and overcome linguistic barriers.

The conservator's profession requires great qualities of concentration because errors cannot be contemplated in the execution of delicate operations that are on the borderline of irreversibility. For this reason, serenity and calmness are crucial to obtaining

high-quality results. In this regard, relationships with the outside are of fundamental importance in the economy of a long-term project such as this – as important as dynamics within the group. This is why the CCA lends so much weight to the conservator's personal profile, together with the professional profile.

Obviously, all this involves greater difficulties in forming and maintaining the group that will take part in the project – difficulties in finding personnel, preparing them for the project, paying them suitably, providing them with what they need and giving support during the long period of the project. Regarding this aspect, at the beginning of the Amiriya project, the CCA was in a particularly favorable position because it had just finished another long and challenging program: the conservation of the archaeological site, mosaics and finds of Zeugma, in Anatolia, Turkey. On that occasion, the CCA had maintained a group of 25 professionals on site for four years, under extreme climatic conditions. They were divided in two groups, which alternated steadily for 45 days apiece. This naturally provided the Amiriya project with a rich talent group of professionals – tried and true professionals who were veterans of "unusual conditions".

New operators – one or (at most) two new faces per campaign for "trial" periods of one month, were also included in the project, for various reasons: reinforcing the pool of available professionals, bringing fresh viewpoints and professional opinions into the group, and (not least) enriching from the human standpoint a group that might otherwise become too ingrown. For the new participants, we drew on conservators trained at the "Istituto Centrale del Restauro" in Rome (a four-year training experience), supplemented by a solid curriculum in the field of wall-painting conservation.

Preparation for treatment

With the executive planning ready, the administrative aspects underway, the group selected and the inauguration date near at hand, all the participants met at the CCA headquarters in Convento di San Nicola for a few days of preparation for the new project. During this meeting, the executive project was presented and discussed with the conservators over a week of in-depth study. Apart from presenting the monument and paintings with discussion of particular technical and operative details, the group also analysed the calendar of work, the composition of the groups and all the other aspects of the program.

In addition to direct information deriving from the technico-organizational debate, the conservators also received bibliographical material and a series of sheets written especially to supply practical information about the country[2] and the logistical features of the project. The free and open discussion among everyone involved helped to prepare the group for potential difficulties – both technical and logistical – in carrying out the project and to create a favorable climate for reciprocal cooperation and a stress-free, productive time living together[3].

Work missions

The length of individual work missions, and thus the extended stay on site for each conservator, is a key element in the good management of any project. For Amiriya, we began with a period of one month, after which a second group replaced the first. This idea was abandoned because a month was found to be too short for them to "get the feel of the project". The new arrivals need at least a week, and sometimes two, to fully enter the work and adapt to the new lifestyle. Once the work arrives at full rhythm, it is almost time to leave again. Then we experimented with periods of two months. This approach was also found to be inefficient because it was too long. A period of two months non-stop causes fatigue, a desire for distraction and physical lassitude; it leads to nerves and malaise and, in general does not contribute to the concentration and serenity needed to focus on high-quality treatments. Another negative feature of the two options mentioned above is that there was no overlap between the groups leaving and arriving, with a resultant lack in technical coordination of operations.

Ultimately, we settled on periods of 45 days per group, with an average overlap of 2 weeks between those arriving and those already on site. This proved to provide a good balance between efficiency and fatigue, between coordination of the groups and overcrowding of the lodgings and worksite. Another feature of the standard program became recreation trips of three days, which provided an opportunity to explore the country and break the routine of daily life at Radà.

The materials (transport and storage)

The restoration of wall paintings calls for the use of known, reliable materials with given characteristics and behavior. This does not necessarily mean that to restore wall paintings, one must employ only technologically advanced materials, or "modern" ones. In any case, such materials would be expensive and not readily available in countries such as Yemen. On the contrary, a correct conservation treatment must be based on compatibility between the materials used today and those used in the past to create the work and/or for its maintenance. Put simply, when a conservator plans and performs a treatment, he or she must give absolute priority to the use of local and traditional materials, after testing them and learning their chemical and physical characteristics and behavior.

This, in principle, is what was achieved in the architectural structures of the Amiriya *Madrasa* before our arrival and also what we attempted to do in the course of the restoration of the wall paintings. More than any other reason, it perhaps explains why the CCA was chosen for this treatment. The use of local, traditional materials, as well as the training of local personnel, have always been the CCA's trademark in the projects it has carried out in the Middle East. And, from time to time, these principles have been cir-

culated and published in the final reports of the projects. In this specific case, lime, gypsum, inert fillers and solvents were obtained locally, following the experiences of Selma al Radi's group in previous years.

The rest of the materials were imported from Italy using the system of "baggage to follow", without resorting to complicated import/export arrangements. Thanks to the availability and generosity of the Yemenia airline, and with a simple verbal agreement with one of their functionaries, the materials were gradually loaded in Rome inside normal bags, leading to great reductions in transport costs. (All of them were on a list of acceptable items for security purposes.) Once at their destination, a member of the Department of Antiquities facilitated their entry into the country. By this process, we not only reduced the costs and time involved in transferring materials but we were also able to be more confident about having what was needed, without running the risk of useless idle time because of shortages. As an example, the materials imported from Italy were restoration watercolors, brushes, protective masks for solvent use, safety equipment, and so forth.

Three different solutions were adopted for storing the materials once they arrived in Yemen, based on the need to have them available at the worksite or nearby, while also protecting these essential items from theft or disappearance. For this reason, we decided to keep a small supply of materials in the storage area prepared in the worksite itself; to keep the major amount of materials and equipment in a storage facility at our lodgings; and, to keep a good reserve at the headquarters of the American Institute for Yemeni Studies at Sana'a, which administered the project.

Unfortunately, events demonstrated several times that such precautions were necessary. Indeed, we must admit that these solutions came from bitter experience during the early months when, to our surprise, we often found ourselves missing essential supplies, to the great detriment of the program. It has to be said that this organization of materials was not just a happy intuition but the result of negative experience in the field during the first months at the worksite.

The worksite (access, scaffolding, utilities, safety)

The organization of a worksite in a restoration project is a key element for a positive outcome of the work program. Safety, rationality, availability of spaces, simplicity, easy access to the painted surfaces, lighting, cleanliness, supply of and access to utilities (water, electricity, waste disposal) are some of the features that a worksite must have for a safe and proper development of the restoration activities planned. Given the broad expanse of the painted surfaces, we decided to proceed by working on three domes at a time, building the scaffolding to cover only the area

concerned. When the treatment of the first half of the surfaces was completed, the scaffolding was moved to the other half. In this way, we were able to save on the scaffolding materials needed and, at the same time, leave half of the hall free – giving us a reference and comparison area and permitting visitors and local inhabitants to use the hall.

In order to build a scaffolding that met standards of quality and safety, we organized a work campaign at the site. For this, a group of specialized workmen and CCA conservators came out from Rome and stayed for three weeks at Radà. In the course of this campaign, an artificial walkway was constructed at a height of 5.20 m, just below the line of round windows, corresponding to the level of the external terrace. This structure was made with a load-bearing tubular scaffold frame and wooden plank floors, covered with sheets of painted, waterproofed plywood. This walkway level was the support for two further work levels built inside each dome. They were 7 and 8.80 meters high, respectively. All the metal parts were protected with antirust paint. Each level inside the domes had a fixed stairway and a trapdoor for access. (Fig. 19)

The scaffolding built in the first half of the prayer hall did not provide access to the work area from the floor below, and the entrance to the scaffolding was through the windows that open to the building's roof. This solution was adopted to prevent intrusions and unwanted visitors in the work area. As the work developed, however, we realized that a direct link to the ground floor of the hall would have been useful. For this reason, a safety stairway was added to the first scaffolding, while the second one was built directly with access from below.

The second scaffolding – i.e., the structure built in the second half of the hall once the first half was done – also had a major change in the heights, with the lowest walkway two meters lower than in the first. This was a simple way to add a work level at the height of the doors and at the base of the lower painted register, leaving the upper levels as they were; it also eliminated the need for mobile scaffolding for the lower parts.

The scaffolding was equipped with an autonomous system for power and lighting and also had portable exhaust fans for use only when necessary. Water and waste disposal were not installed inside the hall for safety reasons. The type of lighting used in the worksite is a major consideration: we installed fluorescent tubes with clear light for restoration. These were low consumption (36 watt), mounted singly or in pairs on simple, quick supports with a plastic protection. They could also be rotated inside the space (Fig. 20).

19 General view of the work-site with the scaffolding.

20 The scaffolding was equipped with an autonomous system for power and lighting.

The entire upper floor of the *Madrasa* was taken over by the worksite for reasons of safety and respect for the work area. No outsiders were allowed access. This helped (at least partly) to limit the amount of theft on the worksite and to completely prevent vandalism on the scaffolding. It also partly cut down on visitor interference in worksite life.

Lodging and movement of personnel

As has been said, the project required the conservators to stay for long periods at Radà, under quite unusual and difficult living conditions.

To provide them with the maximum comfort possible, while using local resources and trying for a "low impact" on the population, much thought was given to housing arrangements.

Indeed, a key element in the welfare of a group working far from home is accommodation, where one must of necessity attempt to create a familiar atmosphere.

For this purpose, we took over the house previously used by Selma al Radi, and renovated it to make it habitable for a group of ten persons of both sexes. It was equipped with bathrooms, kitchen, living room, TV room with a satellite link to Italian and other channels, as well as the bedrooms required. A laundry service relieved the restorers of that chore.

Again on the theme of project organization in order to guarantee the conservators' well-being, we must add that the group had a car and driver always on hand, ready for any eventuality. The driver, who spoke some Italian, also helped with general odd jobs, logistics and, when necessary, security.

Safety

In a professional worksite situation, where one works on scaffolding at potentially dangerous heights, using water and electricity, toxic and inflammable solvents and delicate equipment, the operators' safety is an aspect of great importance. It requires maximum attention to the prevention of accidents and injury.

Prevention of accidents is based on the conservators' professionalism, the level of their information about the project at hand, and the psycho-physical state in which they operate. All this explains why we invested so much effort in forming a reliable, compact group, in giving them information about the project details, and in providing good living and working conditions.

Prevention is also based on the way a worksite is organized, managed and maintained – i.e., the workplace. And this explains why so many resources were invested in organizing and equipping stable, safe scaffolding, in setting up a storage area apart from the hall for keeping inflammable solvents, and in building an electrical plant to code, with circuit breakers.

Documentation

Today, documentation is perhaps the aspect that best indicates the level of maturity achieved by the profession in performing conservation treatments. Numerous texts have been written to explain why documenting a major restoration treatment is such an essential operation. Documentation means that information is accessible to all – now and in the future – about what the conservators encounter and gather during the treatments, and it is made both available and circulated afterward. It means leaving a picture of the current situation, as it was found by the conservator before and after treatment, providing a record of what was done in the course of the work.

In the case of the Amiriya project, three parallel documentation techniques were used: 1) graphic documentation for internal use on the worksite, which involved drawing thematic base maps where one could record all the characteristics that were encountered during the work; 2) photographic documentation – both worksite photos taken by the conservators and proper photography campaigns done by a professional (Araldo De Luca); and 3), digital video documentation in order to leave a record "in movement" of the operations performed.

Circulation of information to the public

Circulation of the results obtained in the course of restoration has always been an activity to which the CCA devotes considerable attention and resources. In the past, this objective was reached by publication of the data obtained during treatment, as well as opening the worksite (conditions permitting) to the public so that visitors, academics and journalists could personally follow the work.

The most recent of these open worksites was for the conservation of the Centaurs in the Capitoline Museum in Rome, and the initiative was recognized at the international level when the International Institute for Conservation (IIC-London) awarded the 2004 Keck Prize to Andreina Costanzi Cobau of the CCA. It honored the conservation project that had done the most to raise awareness of the fragility of cultural heritage and the role of the conservator.

In the case of the restoration of the wall paintings of the Amiriya *Madrasa*, this aspect was more complicated, given the place (Radà), the type of building (a mosque open for worship), and a certain "detachment" on the part of the local populace. It seemed best to limit access to the worksite but, nonetheless, we attempted to facilitate visits by organized groups, journalists and local authorities.

Thanks to the support of the Italian Ministry of Foreign Affairs, we have also published this volume in order to provide maximum circulation of information about the treatment.

Other initiatives devoted to the diffusion of the project results, and again supported by the Italian ministry, were the organization of an international seminar on the theme of protection of cultural heritage and its role in "cultural tourism" in view of what is hoped will be an increase of visitors to the Radà region, as well as the production of 15,000 postcards depicting the Amiriya *Madrasa* and Radà. The book and the postcards represent a modest contribution to providing informative material for personnel at Amiriya to sell on site and earn something towards the ordinary maintenance of the *Madrasa*.

21. The course participants during a session on documentation.

Training course and maintenance plan

Yemen is rich in works of art, but the situation is quite fragile in terms of their maintenance and conservation. There are at least 45 mosques in the country, dating between the 13th and 16th centuries. Their prayer halls are entirely decorated with stuccoes and tempera paintings, which need care and restoration followed by periodical maintenance. To meet this need, the Ministry of Tourism and Culture is working on concrete strategies and is also establishing new, more efficient operative structures. The GOAMM is being completely reorganized, with the creation of new operative departments, combined with radical changes, particularly in the area of museums and historic libraries. In this program, the government of Yemen has appealed to Italy in view of creating a special operations unit for the safeguard of wall paintings.

In this regard, we must also mention the methodological premise upon which the current project was based from its inception: seeking the conditions necessary to assure future sustainability of the results obtained by the treatment recently performed and activating a plan of periodical maintenance and continuous monitoring of the monument. For these two reasons, the Italian Ministry of Foreign Affairs, General Directorate

22. The future of the Amiriya is in the hands of a regular implementation of the maintenance program.

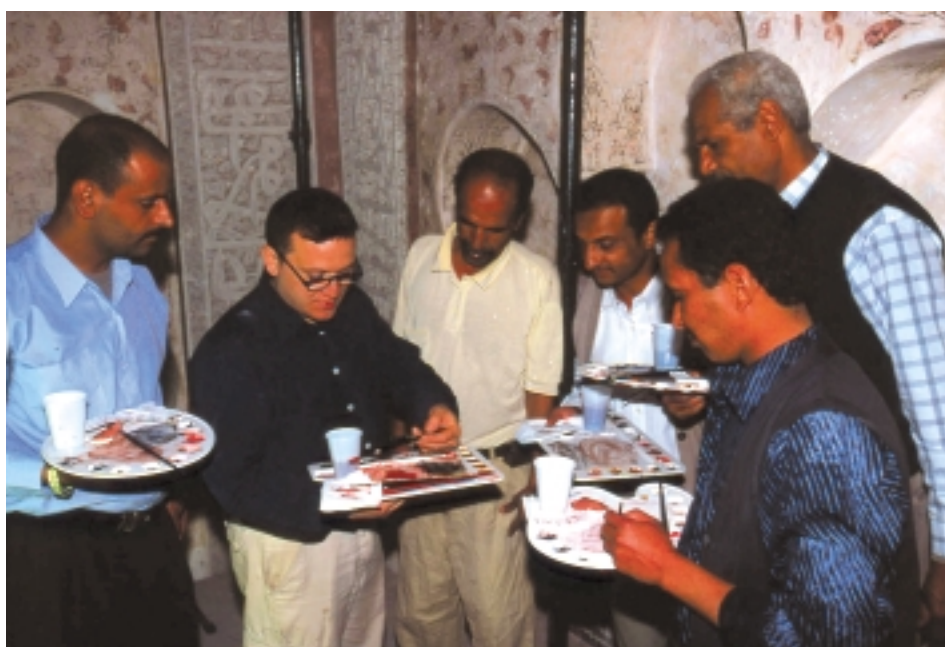
23. When training during actual work, theory and practice proceed at the same time.

24. A conservation work-site provides the participants with the opportunity to get experiences in direct contact to the professionals.

for Development Cooperation readily welcomed the request from the Antiquities Department (GOAMM) to finance a six-month training course in wall-painting maintenance for six Yemeni technicians already on the GOAMM staff and to entrust the CCA with organizing it and doing the training.

This course grew out of a year-long collaboration between the CCA and GOAMM, whereby the Yemeni technicians worked alongside the conservators on the scaffolding as part of their training. The formal six-month, structured course followed the program that began in 2003. The topics covered included both the theoretical principles of conservation and maintenance of wall paintings and the more technical aspects of painting restoration. The purpose of the course was to introduce the group to professional methodology aimed at maintenance of the painted surfaces, while also laying the groundwork for continuing training intended eventually to create a group of wall-painting restorers at the service of the country's cultural heritage.

Raga'a Abdu al-Akwa, Muhammad Salih Yahya al-Qadi, Amin Salih al-Mawari, Ahmad Abdallah al-Jahafi Adil Sa'id, Ahamed Belah, Muhammad Saleh Elkadi were the course participants: they merit recognition for their quality, commitment and motivation, which made this training experience highly productive and also extremely pleasant. Warmest thanks to them all. (Fig. 21-26)



25. When training during actual work, theory and practice proceed at the same time.

The major challenge one encounters in training restorers of works of art is to transmit the ability to put theoretical principles into practice, so that students acquire manual dexterity and the ability to discern what techniques to adopt in any given case. Thus, it is of fundamental importance to have a worksite where theoretical learning can be applied: a period of training on site, during which the needs and reality of a country and its heritage are brought into focus.

The occasion for a hands-on internship was provided by the Amiriya mosque of Rada', especially for the restoration of the wall paintings, which gave the technicians the opportunity to combine theoretical instruction with an apprenticeship in the field and assimilate the theoretical principles. They were thus able to learn by doing, taking an active part in the work alongside experienced specialists and seeing – at the end of the course – the completed restoration to which they had made their own personal contribution. Ultimately, the specific objective had several parts: institutional support to GOAMM, training of Yemeni technicians and organizing a group to look after future maintenance of the building and its paintings.

26. The course participants had the opportunity to study the original painting techniques together with the conservators.

Conclusions

From a strictly technical point of view, the recently concluded treatment has raised some reflections of a methodological nature, highlighting potential risk factors. Indeed, there is no doubt that introducing a profoundly Western theoretical approach into places with very limited resources and a different culture means that, on the one hand, great effort is required to ensure that the approach is understood by focusing the treatment on real conservation requirements, on respect for traditional materials and on the cultural demands of the country. On the other hand, one must – apart from the technical treatment – make every effort to create the conditions for an autonomous capacity for protection and care of the heritage. These are perhaps the main features that characterized this program, in the course of which we attempted to look at the monument's future and respond to the specific need to develop self-sufficient operational capability at the local level.

The divulgation of principles and treatment techniques that are common and second nature to us can take on the connotations of the exportation of cultural models; as such, they call for a great sense of responsibility. Thus, we asked ourselves whether it was more important for our Yemeni colleagues to understand that the life of works of art is unique and unrepeatable, given their extremely fragile nature, and calls for continuous care above aesthetic considerations; whether it was best to focus on easily copied operations, mostly using materials available locally, instead of preferring more elaborate systems and hard-to-obtain materials; finally, we asked ourselves whether in their country, as in our own, it is more important to train personnel prepared to plan and perform all the measures necessary to prevent damage to the works, instead of treating damage that has already happened. The answers we attempted to give spring primarily from having gone past a curative approach to a preventive one, where maintenance is the main form of conservation. It is certainly viable in any part of the globe because it does not call for high technology and vast economic resources, and it lays the groundwork for a sustainable future for our shared heritage.

The conservation/restoration program for the wall paintings of the Amiriya *Madrasa* of Radà is over. The paintings glow again in all their magnificence, and the building is again ready for worship and open to visitors. The destiny of this monument is now linked to the way in which it will be used and, more importantly, to the way it will be cared for and maintained.

This program required great commitment from numerous standpoints: technical, organizational and logistical, financial, human and diplomatic. We knew that it would not be easy to arrive at the end of this long adventure, which lasted almost five years.

We got there by facing and resolving the difficulties that could be overcome – perhaps more easily than expected. And, in my opinion, we got there by meeting all the objectives we had set ourselves: the restoration of the paintings, the training course for local operators, and the publication of the results obtained.

From the standpoint of the personnel who participated in the project, the greatest satisfaction for the project director is undoubtedly the enthusiasm and self-sacrifice demonstrated by the conservators right up to the last day. Their sense of commitment has been confirmed by the potential availability of all concerned to start a new project in the same region.

Our heartfelt thanks go to them and to everyone who, in various ways, contributed to the realization of this project.

NOTES

[1] Raccomandazioni Normal - "1/88 Alterazioni macroscopice dei materiali lapidei: Lessico" , ICR-CNR, Roma, 1988.

[2] Chiara Zizola, *"Informazioni generali sullo Yemen"*, a paper that supplies information such as: geography and territory, population, climate, time zone, language, religion, history, constitution, political situation, economy, festivals and popular traditions, links, bureaucracy and visas, vaccinations, what to pack, electricity, costs, useful addresses, airport and entry taxes, what to see and do, where to stay or eat, mail and telephone, currency, credit cards and exchange rate, getting around, health, security, behavior, what to avoid, The Qat.

[3] *"Alcune risposte a domande comuni"*, a paper supplying answers to FAQs such as: How will I travel? Do I need a visa? Do I need vaccinations? Should I bring money? Who will meet us at the airport? Are there any formalities on arrival at Sana'a? Where will we stay? What should we bring? What should we not do? Is theft a problem?

Capitolo 3

OBSERVATION ON THE ORIGINAL PAINTING TECHNIQUES

Chiara Zizola

The conservation program of the wall paintings that adorn the prayer hall of the Amiriya *Madrasa* offered a rare opportunity for in-depth analysis of the techniques used, and the operative models followed, in creating the paintings. The entire surface still bears traces of the tools that the artisans and the artists used. Together with an analysis of later deterioration, these allowed us to reconstruct the full production cycle, and the historical and conservation events that affected the paintings. The total lack of historical documents referring to the construction and decoration of the building prevented a definitive interpretation of the data. But the hypothetical interpretations presented below are consistent with the data and also with centuries-old worksite practices common to the pictorial arts from east to west across our planet. These practices have been handed down in ancient technical manuals on painting from different historical periods and regions, and by other documentary sources.

The study of techniques and materials in the Amiriya was performed by visual analysis and recording the technical evidence on a base map (drawing), and by laboratory tests to obtain a more specific characterization of the constituent materials.

Starting from the supposition that the paintings are the completion of a defined architectural space and are, therefore, adapted to an environment prepared to receive them, we here attempt to trace the phases of their production. On the one hand, it will be seen, their creation follows the methods of architectural production and thus calls for project planning, building skills and knowledge, availability of materials, and organization of the work. On the other hand, it calls for skills related to wall painting itself, which involve a mastery of drawing and paint as forms of expression.

The technique

The paintings are done in tempera on a gypsum-based plaster. The principal characteristics of this painting technique lie in the use of an organic binder to mix the pigments and to make them adhere to a dry wall that had already been prepared.

Tempera is perhaps the oldest wall-painting technique known; over the course of history it has had numerous regional variants, generally conditioned by the types of locally available materials, and the climate. Indeed, this technique is among the least resistant to deterioration, as it is extremely susceptible to moisture.

Widely found in all civilizations, the use of tempera to decorate architectural surfaces is prevalent in the Middle East and was used since the very beginning of painting in Iran, Iraq, Syria and Turkey, in addition to Egypt and India. Apart from being traditional in the area, the use of tempera is linked to its suitability to creating highly detailed and tiny decorations, such as those that characterize Islamic art, where the representation of geometric elements, plants and inscriptions reaches high levels of elaboration[1]. These would be difficult to obtain in a monumental building with a technique such as fresco, where the painting time is limited by the drying time of the lime-based mortar of the support.

Wall support and plaster: composition and application

Observations made where the paint was missing (lacunae) made it possible to see the entire stratigraphy of the support, understood as a combination of the masonry and the preparatory layers spread over it to receive the painting.

27. Dome 4. Stratigraphy of the support with the brick structure evident.

28. Dome 5. Detail of the brick structure in an area of missing plaster.

The wall support is composed of baked mud brick, laid with clay mixed with vegetable fibers (Fig. 27-28). Small wooden beams are inserted in the masonry at regular intervals, horizontally and transversally inside the structure to form a grid. This makes the structure more elastic and permits a proper distribution of the load and partial absorption of vibrations during earthquakes[2]. These wooden inserts are not visible in the vertical walls because they are covered with plaster, but can be seen in the domes, where they protrude at least 5 cm from the painted plaster (Fig. 29).

29. Dome 1. Detail showing 11 small wooden beams in situ.

The front section of the beams shows traces of painting done directly on the wood, with the same motifs as the surrounding painting (Fig. 30). Some of the beams are used to suspend hanging lamps, and these still have the original iron rings inserted into their ends. Apart from supporting the lamps, the protruding beams might be related to the process of constructing the domes themselves, when the artisans used wooden counter forms and needed to attach them somehow to the load-bearing structure. Only small portions of the beams can be seen today. They might have been inserted into the walls to anchor the counter forms, and afterward sawn off, leaving only the beam ends useful for hanging the lamps.

Basically three preparatory layers make up the specific support of the painted surface and cover the masonry. The first layer, in direct contact with the masonry, is a mix of clay and chopped plant fibers, the latter added to strengthen the mix and to keep it from contracting too much and developing cracks while drying. The main function of this layer is to fill in the spaces between the bricks, to isolate the wooden elements, and to form a regular surface in preparation for the actual plaster intonaco[3].

30. Dome 1. The face of the beams shows traces of painting done directly on the wood.

31. Dome 2. The surface roughness of the thin layer on the intonaco makes it appear to have been brushed on.

The first layer of plaster is spread in a thickness that varies from 5 millimeters to 1-2 cm, depending on the curvature of the walls; the second layer, which will be painted, is spread more thinly, no more than 2 millimeters thick. Observation under raking light brought out a certain surface undulation that follows the shape of the underlying bricks. This effect was most likely the result of repeated working and pressing the damp mix in order to get it to adhere to the layer beneath, and smoothing it with a flat tool such as a plasterer's trowel or float. The surface roughness of the thin layer above makes it appear to be brushed on (Fig. 31).

Microscopic analysis[4] under reflected light on cross-sections and thin sections of a sample of the plaster taken from dome 2 identified the matrix as gypsum ($CaSO_4$), anyhdrite, in which is mixed very fine crystalline calcite ($CaCO_3$) and kaolin with rare inclusions of quartz (SiO_2) and feldspars. As for spreading the plaster, it was only partially possible to identify the sequence of the work. Certainly, as is usually the case, the plaster was first applied to the domes and then to the surfaces below the domes. Judging by areas of overlapping plaster, the procedure seems to follow a logic dictated principally by scaffolding in use, and very likely it extended over several domes at the same time.

The plaster applications, mostly uniform within the domes, are interrupted where they meet the elements that define the lower register; this interruption might coincide with a first level of the scaffolding. In the lower register, which is highly articulated from the architectural standpoint, we find superimposed plaster applications in the niches and blind arches. Here in particular, as observed in domes 1 and 2, the plastering is rather sloppy, and in several areas (especially concave ones), the surface reveal traces of smoothing and working, almost as if the plastering tools could not follow the shape of the surface.

The overlapping plaster at the lower border of the blind arches presumably marks the height of the scaffolding used for working that register. Moreover, we can hypothesize that when they were being worked, the blind niches were crossed by beams of the scaffolding, which would have permitted the structure to extend to the domes nearby. Thanks to the almost complete detachment of the plaster in one of the blind niches of dome 1, it was possible to see that the inner wall is not solid masonry, but has an air space. Additionally, these niches differ greatly in both the composition of the plaster (grainy and almost grey, as if it contains a lot of sand) and in the way it is spread, which seems to be just a hasty fill, albeit subsequently painted (Fig. 32).

Other overlapping plaster areas occur in all the underarches and the walls above the columns at about 4 m above ground. Most of these were not painted, although domes 2 and 6 were painted with the same original motifs, albeit obviously done in different colors (Fig. 33). These rough overlapping areas also appear to be patches to connect parts of the masonry that probably could not be reached when covered with the scaffolding used for doing the level above the doors. The fact that the same areas decorated in stucco do not have any breaks can support this hypothesis. One cannot rule out the possibility that the areas of rough plaster were later repairs of damage done by settling or seismic events, but this explanation seems fairly improbable since the stucco decorations in the same areas of the masonry throughout the room bear no trace of damage and subsequent repair.

32. Dome 2. The blind niches show an overlapping of the intonaco which seems to be just a hasty fill, albeit subsequently painted

33. The underarch between domes 1 and 2 seems to show an area inaccessible when the original scaffolding covered it.

In dome 2, however, we found a second plaster application across half the dome, made after the first plastering. Although heavily damaged, the second plastering covers traces incised with a compass (Fig. 34) to divide the surface of the first plastering into various decorative fields.

Errors in the preparatory marks for the painting are obvious on the other half of the dome, and this observation suggests that the second plastering covered serious mistakes in the composition of the painting design, which then were corrected on the second plaster surface (Fig. 35).

Laying out the decorative scheme

After the structural surfaces had been plastered, the plaster surface was divided into various decorative fields. Most of the incisions were made on still-fresh plaster, and are easy to identify. They horizontally divide the walls and domes according to the compositional program to be followed.

34. Dome 2. The intonachino (a second strata of intonaco) covers traces incised with a compass to divide the surface of the first plastering into various decorative fields.

36. Dome 1. The mark left in the incisions are typical of those made in fresh plaster using a wooden stick

35. Errors in the preparatory marks for the painting are obvious on the other half of dome 2.

Various tools were used: a compass, cords, a plumb line, a ruler and a pointed tool, perhaps simply a wooden stick used to mark the measuring points on the plaster. In some cases, these points are quite large and coarse, making one imagine hasty work by untrained personnel. The marks left in the incisions are typical of those made in fresh plaster (Fig. 36).

In the domes, once the measuring points were marked, the first division of the spaces was done with a compass and with the aid of a cord fixed to the peak of the dome in order to mark the horizontal circumferences that determine the height of the compositional fields (Fig. 35). With minor variations, these circumferences are repeated in all the domes. They are structured around a central circular decorative motif, followed by an outer band decorated with geometric or plant motifs. Only in domes 1 and 5 is that band followed by a band of inscriptions. The procedure for incising the circles was simulated during a study phase *in situ*, and the marks on the plaster correspond exactly to those produced by fixing a cord to the center of the dome.

Surrounding the central motif is a wide band with various decorations that combine geometric elements, plants and flowers into a spectacularly rich decorative and chromatic whole; these decorations are delimited by a band of inscriptions on the lower border of the dome. The first circumference delimits the central motif, followed by one that marks the edge of the outer decorative band, and so on. In the widest points of the dome, the circuit was traced in two stages (two semicircles), and the meeting points of the marks are visible.

The circumferences were executed with considerable imprecision; sometimes the obvious mistakes again suggest that the workmen involved in this phase were not trained in wall painting, but were simple plasterers. Dome 2 especially shows evidence of faulty initial layout of all the decoration, with the incisions completely shifted with respect to the decoration actually carried out (Fig. 35).

In the walls beneath the domes, the first spatial layout (with incised measuring points) divides the wall in half, both vertically and horizontally, and also marks the upper and lower edges of the horizontal decorative bands. This overall division of the fields with incisions facilitated the next phase in which the space was broken down in more detail and the individual motifs were represented in the preparatory drawing.

Preparation for painting: the preparatory drawing

Losses and wear of the painting made possible a very clear reading of the procedure used to transfer the pictorial motifs to the walls, through the execution of a drawing that acted as a guide for the subsequent execution of the painting itself.

Two distinct procedures are evident: the first was more complex and used for the fields with repetitive geometric motifs and for the Kufic inscriptions (Fig. 37); the second was used for the execution of floral and plant motifs and for inscriptions[5] in a cursive style similar to *thulth*[6]. In both cases, the preparatory drawing is executed in red ocher, using cord-snapping, a ruler and brushes of various sizes.

The execution of the geometric motifs called for two drawing sequences: in the first, a grid was marked out with vertical and horizontal lines by snapping a cord; after that, further reference lines were made inside the grid for the execution of the final design (Fig. 38).

37. Dome 4. Detail of the Kufic inscriptions repeating the name ʻAli in wide bands traced in red ocher.

38. Dome 1. Execution of geometric motifs involved two drawing sequences: first, a grid was marked out with vertical and horizontal lines by snapping a cord; then, further reference lines were made inside the grid for execution of the final design.

Cord-snapping is commonly used in wall painting as a quick way to make straight lines. It is done by marking the plaster (with a brush or small incisions) at the top, bottom and side distances established. A cord soaked in pigment is then fixed to the marked extremities, generally by fastening one end with a nail and holding the other end with a finger. The cord is then pulled taut and released to snap against the plaster, where it leaves a line of pigment. Many areas of plaster still retain the imprint of the cord, a few millimeters in diameter, with characteristic splashes of color produced when the cord strikes the wall. Many of these lines overlap because they were done hastily or – as in the case of dome 2 – they were crooked and then done over in the correct position. The nature of the pigment used was determined by analysis under an optical microscope and by chemical analyses.

The grids were mostly traced by cord-snapping, although we cannot rule out the more traditional use of a brush and ruler. The grids differ according to the intended individual motifs represented: starting with simple squares, they are enriched by added lines that facilitate rapid execution of the final design.

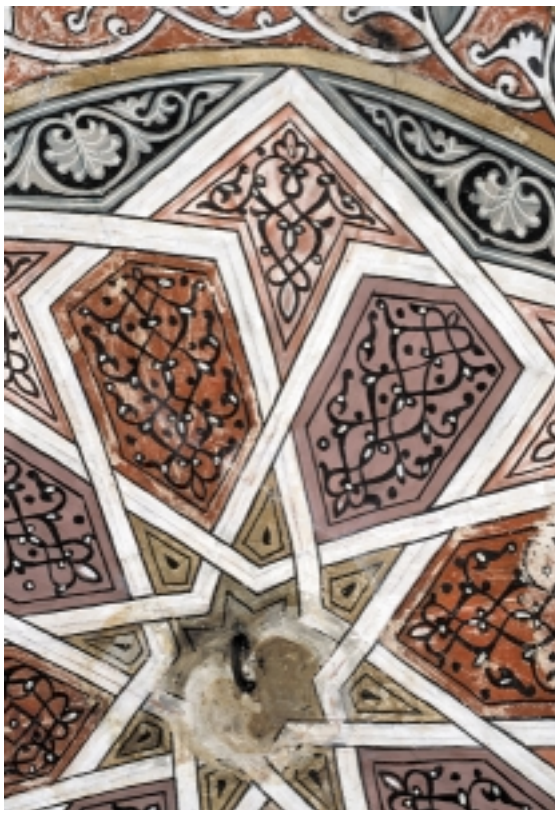
In general, we can state that by using a grid, one could execute all the geometric motifs without having to mark measuring points on the surface. Thus, the grid represents a sort of standardized scheme that permitted execution of the final drawing and the subsequent painting with a simple, rapid procedure. Such conditions are indispensable when several people are working on the painting at the same time. Oblique lines on the grids occur at the center of the white bands that define the final geometric motifs. The oblique lines represent a crystallisation of the final geometric design, which is always delineated by white bands 2 cm wide, done over the underlying guideline. In all likelihood, the line indicated where to place a ruler 2 cm wide, so that one could quickly trace the outline of the final design in one go, resting the brush above and below the ruler (Fig. 39).

This procedure was found on all the geometric motifs, where on close examination these median lines are easily seen within the white outline bands.

The red line, done with a brush, is a few millimeters thick and the color is generally light, because it was diluted in water and applied on plaster that was still damp. As it is only a guide for the execution of the final design, it was meant to be hidden under the colors added later.

The final drawing of the geometric motifs completed preparations for the painting to begin. This final drawing followed the underlying grid, and was always executed in red ocher but using a darker, more full-bodied color and the tip of the brush. It was destined to be followed by black contour lines in the final phase. This drawing is not visible in most of the paintings because it is covered by the colors added later. In areas of paint loss, however, one could see that different hands worked on it. Clear, clean decisive lines made using a ruler alternate with drawing done in a confused and imprecise way – the latter was often wrong and sometimes done freehand (Fig. 40).

The execution of the preparatory drawing for the plant motifs and inscriptions was simpler, and was mostly done freehand in the definitive version. Different hands can also be identified in this case: some are more expert and secure, others are hesitant and imprecise (Fig. 41). In some cases, the repetitive plant elements may have been drawn with stencils, so that leaves and flowers could be rapidly drawn. Many of these elements can be superimposed and match in form and final shape. The preparatory drawing in



39. Dome 2. The lines, visible at the center of the white bands defining the final geometric motifs traced the outline of the final design.

40. Dome 1. Detail of the decorative motif of the blind niches. The preparatory drawing and the application of the color are made rapidly and unprecisely.

such cases is limited to defining the contours of the main forms, while the internal details were worked as the painter went along, without guides beneath (Fig. 42).

In conclusion, analysis of the preparatory drawing suggests that the technique was based on the widespread use of measurements, as can be seen in the incised points and painting identified on the surface and the synthetic reference schemes, constructed with circumferences and vertical, horizontal or oblique lines. This system conforms to techniques commonly used to transfer a drawing to a wall and to enlarge it from the scale of the decorative project and/or a model to the typical dimensions of architectural surfaces.

Finally, a codified system of mathematical and geometric ratios may have been used to adjust the proportions of small-scale motifs to a monumental scale, especially where there are curved surfaces such as domes where optical distortion would have affected the final result[7].

The existence of project drawings for the pictorial decorations, in addition to those for the architectural features, should not come as a surprise. Drawings not only enabled the client to visualize the proposed final result (and thus give the necessary approval), but it was also an indispensable tool in planning the operations – from the distribution of resources to the acquisition of materials, from the hiring and organization of the work force to the calculation of the time required to complete the work and up to the executive planning of the scaffolding, as is always the case in any monumental architectural work.

41. Dome 1. In areas where the original color is missing may be seen the preparatory drawings made with red ocher.

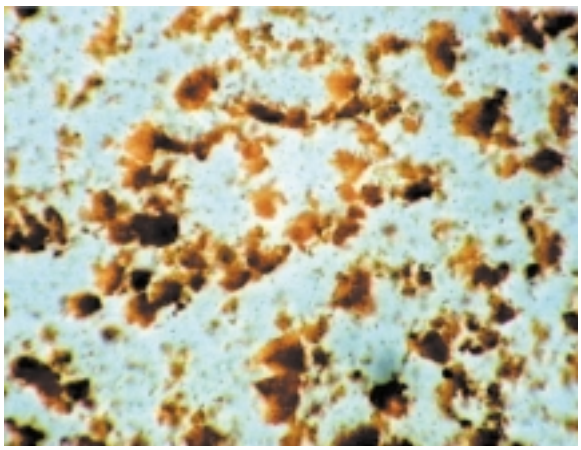
42. Dome 2. Decorations made with vegetables and flowers are richly decorated with arabesques made free-hand, without preparatory drawing.

Execution of the painting and the palette

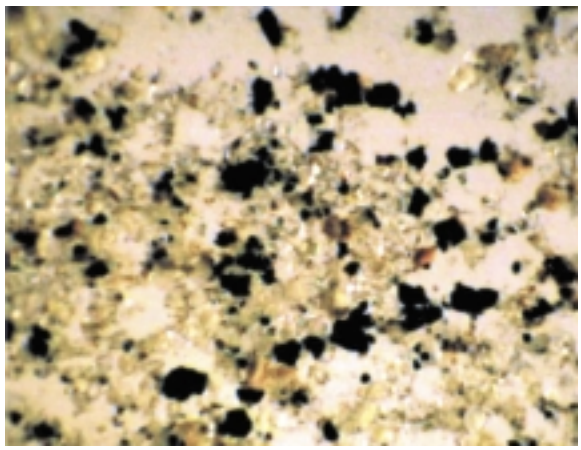
A rich range of colors makes up the palette used in executing the paintings, further enriched by gold leaf (now lost) originally applied on the inscription above the *mihrab*, with raised letters on a blue ground. Small gilt areas still remain in the underarches surrounding dome 3, at the center of the painted star motif.

Chemical analyses performed on paint samples confirmed the use of both a proteinaceous binder and gum Arabic for applying them. Analysis also helped identify the most significant pigments, such as blue, red, yellow, green, white and black. The pigments, both minerals and organic, are often applied in mixture to obtain different hue values.

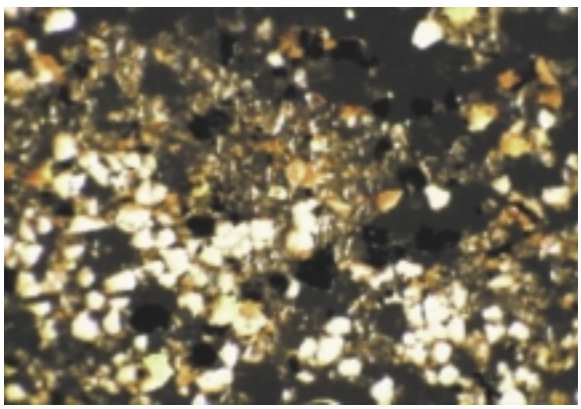
Red (cinnabar) and blue (indigo) are used in the grounds of the dome and in the writing, and the two colors are variably combined with yellow (massicot), orange (realgar), green (green earth), browns, pink, purple (indian red), white (kaolin) and black (ivory black) in all the other elements (Fig. 43-46). White plays a key role in the bands of the geometric motifs, in the inscriptions, in the bunches of fruit and in highlights. This pigment reinforces and stresses the other colors, and brings out the elegance of the decoration.



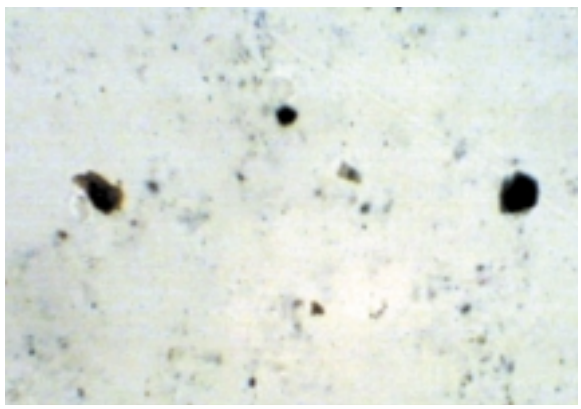
43. Microphotography 500 x on red sample. Red particles can be attributed to cinnabar



44. Microphotography 100 x on yellow sample. Visible are particles of ivory black, massicot and realgar



45. Micro photography 100 x reflected ligth. Numerous particles of white marble are mixed into the mass.



46. Micro photography 500 x on blue sample. Particles of indigo with traces of Lapis lazuli can be seen.

As described in numerous medieval treatises on Indian and western painting technique[8], walls intended for tempera paintings were treated with a solution, normally glue or egg diluted in water, after the design drawing was done. This solution was applied with brushes or sponges over the entire surface to be decorated. Upon drying, it lessened the porosity of the plaster, and thus facilitated the painting process and enhanced the chromatic effect.

Paint loss in some areas exposed traces of a heavily altered thin grey film that is insoluble in water and in the main solvents used during the painting conservation. One can even see numerous drips of the same material, which fell when it was being applied, at the inferred levels of the scaffolding erected inside the domes for execution of the work. The drips have the classic random appearance that comes from comes with rapidly brushing a liquid onto a vertical surface. Chemical analyses detected the presence of beeswax (punic wax) on the surface, as intentional finishing of the painted surface or maintenance layer.

Once the surface was dry the painting could begin, following the underlying preparatory drawing. The brushwork (which also demonstrates that the hands of different painters were involved) is rapid, inaccurate and also often strays outside the limits of the preparatory drawing; in other places it can be precise and clean, especially in domes 6, 5 and 3.

The brush-strokes are done in uniform colors with no shading between adjacent colors. They are enriched with tiny details done with the tip of the brush, and end with outlining the designs in black. The strokes are concise, and show a rapidity in execution that would suggest the development *in situ* of well-known decorative motifs and the presence of a reference model that was clear to the painters as they worked. The method is constant and always follows the same sequence: first the uniform ground tones are applied, limited to the fields defined by the preparatory drawing (and thus not extensive); next the painters execute the smallest linear details, such as arabesques and the internal parts of leaves and flowers, with the tip of the brush; then all the motifs are outlined in black, which corrects spots where the color has flowed beyond the limits of each motif.

In places in dome 2 where the plaster had fallen (corresponding to the overlapping plaster in the lower border of the blind arches), we noted paint on the plaster surface partially covered by plaster of the surface below this level (Fig. 47). It thus seems probable that the paintings were completed within the domes down to the level of the scaffolding, and then the work shifted (probably moving the scaffolding) to the lower registers. The scaffolding level thus defined the lower edge of the surface to be painted, and the progress of the work followed the order of the horizontal bands that coincided with the various decorative sections to be executed.

Errors, second thoughts, erasures, overpainting: the hidden side of the paintings

Analysis under raking light of the surfaces revealed a large number of erasures, mistakes in executing the preparatory drawing and compass incisions, shifts in the final painting with respect to the underlying preparatory drawing, and corrections of the painting by over painting.

Viewed from below, the final painting hides the history of its creation. But the painting seems to be the result of a team that labored under the supervision of a master painter – perhaps even the person who conceived and planned the entire project – who modified the work of his assistants.

Corrections were found over the entire surface, both to the delineation of spaces with compass incisions – including a second plastering of half of dome 2, the overall layout of which was completely botched – and to the preparatory drawing. The corrections were made mainly by scraping the surface with a sharp tool until the red marks were removed, and then re-drawing them in the new position.

Among the six domes, domes 1 and 2 bear the most errors and erasures, and they also have over painting of entire portions of the painting. These mistakes are most abundant in the inscriptions on the arches (Fig. 48), where letters already traced in the preparatory drawing were completely erased and done over in different positions. Even in the final phase, with the painting already completed, over painting of these inscriptions was necessary to correct the height and shape of letters (Fig. 49). Over painting, which modifies an already finished painting, is also present in the lower part of the hexagonal decoration of the blind arches of domes 1 and 2, where the re-painted interior of an entire leaf partially hides the mistakes. The color used in the over painting is in very good condition, probably due to the use of a larger amount of binder in the paint.

The far greater number of corrections in domes 1 and 2, compared to the other domes, suggests that the work force underwent a substantial change in the rhythms and competence in these two domes. This suggestion provides fertile ground for various hypotheses and interpretations. The reduced ability to execute the project, evident in the high incidence of errors both the overall layout and in the painting itself, might suggest a change in workmen, or pressure from the client to finish the painting, or other external reasons.

Only documentary sources could answer these questions, but it seems that these two domes were the last to be done in the worksite, where the original rigor and order give way to a hesitant – often clumsy – procedure marked by extreme carelessness and haste. Comparison of identical decorative motifs used in a symmetrical program between domes 1 and 5, and 2 and 6, highlights the difference in style and technical quality, and certainly confirms that different painters were at work, although we cannot explain why.

47. In dome 2 where the plaster had fallen we noted paint on the plaster surface partially covered by plaster from the surface below this level.

49. Dome 1. Detail of an original over-painting on the inscription made in order to correct a letter.

48. Dome 1. Analysis under raking light of the surfaces revealed a large number of erasures, mistakes in executing the preparatory drawing in the area of the inscriptions.

The worksite

The application of the paint to the surfaces, as we have already seen, constituted the final phase of a complex procedure that most probably began with planning the work as a small-scale drawing. The entire decorative layout was thus presented as drafts that the client could visualize the final result, or to which the client could suggest changes. On the basis of these drafts one could establish in advance all the phases of the work, and could distribute tasks accordingly. Indeed, in the planning phase one could estimate the number of artisans and the specializations needed within the time and budget limits, calculate the quantity and quality of materials required, and organize the spaces, materials and men.

From the material evidence on the walls, it would seem that a painter was in charge, the planner and foreman of the enterprise. He was probably responsible for the final touches and probably also, as suggested by the interventions described above, for execution of the most minute details. Meanwhile, the execution of the general decorative scheme was probably carried out by artisans organized by specialization and in a hierarchy under his direction.

The presence of several men in the worksite is shown not only by the great number of second thoughts, errors and erasures in the final preparatory drawing (especially in the inscriptions), but also by the grid system used to standardize the execution of the geometric motifs. Once the grid in place, the painters followed a sequential process: first the grounds, then the internal details and then the final linear outlines.

In a 1633 treatise, "*Dialogos de la pintura*", written by the Spanish painter Carducho, we find confirmation of a common procedure creating a painting that seems to explain what we observed in the Amiriya paintings: "*The expert painter's tasks are to make sketches, to study every part of a composition separately, and then to join all the parts in a finished cartoon or drawing, arriving at the composition according to the precepts of good art. He gives this and other drawings to the oficial, who transfers or draws them onto canvas or wall by the squaring system; he then paints the boquexo (underpainting), and applies the colors, which is called finishing or impasting. The master is present to watch with care, to advise with words, and to correct with the brush when the oficial errs or when the work does not agree with the drawing (this is called corrupting the contours). When the oficial leaves the painting as finished, the master comes back to retouch and perfect it, which is the ultimate step*"[9].

This type of work organization, which called for a firm division of tasks in a hierarchical system, is described in numerous sources and documents, particularly in connection to major medieval Italian worksites[10] where a large number of workmen were employed.

The division of labor by specialization meant that the individual artisan had a limited number of actions to perform, which improved the quality of the work and speeded up

performance. The conceiver of the painting, the planner, had to strictly direct the work. Moreover, this division of labor allowed the master painter to find the people needed to carry out preparatory phases, such as preparing the mix, grinding and mixing the colors, plastering, etc., directly on-site. He would use the men in his own workshop, or would recruit people from other artists' workshops nearby, to do the painting.

Although there are no documentary sources available for the Amiriya worksite, there is direct evidence of the persistence of a type of work organization that follows traditional building practice in Yemen today[11]. It certainly indicates how little has changed over the centuries in the work of an artisan.

NOTES

[1] For a description of the paintings and the historical evolution and the decorative motifs represented, see Venetia Porter, "*The Architectural decoration of the Amiriya. Painting, Stucco and Qudad*", in The Amiriya in Radà, The History and restoration of a sixteenth-century madrasa in the Yemen, by Selma Al-Radi, Oxford Studies in Islamic Art, XIII, Oxford University Press, 1997, pp. 113-138.

[2] On traditional construction techniques used in Yemen, see in this volume Selma Al-Radi, "*The Restoration of the Amiriya*".

[3] A clay-straw mix is widely used in Yemen in traditional building and structural maintenance. We were able to see the preparation of the mix first hand during the maintenance of the mud oven for cooking lime, which was purpose built near the Amiriya for producing the lime needed for restoring the building. Clayey soil and straw are mixed in a circular pit in the ground, with the latter making up about a third of the volume. The work is a group activity, with a firm distribution of tasks. Two people mix the materials with their bare feet and hoes, while a third person adds the water necessary bit by bit as the work proceeds. A fourth person deals with the clay. When the mix is ready, it is loaded into buckets and passed along a human chain to the plasterer. The entire operation is carried out to the accompaniment of song.

[4] Analysis were done by studio C. Meucci of Rome, Italy.

[5] Kufic inscriptions in the 'Amiriya are repetitions of the name 'Ali in wide bands; see Venetia Porter, *"The Architectural decoration of the Amiriya. Painting, Stucco and Qudad"*, in The Amiriya in Rada', The History and restoration of a sixteenth-century madrasa in the Yemen, by Selma Al-Radi, Oxford Studies in Islamic Art, XIII, Oxford University Press, 1997, p. 128 and pl. 75.

[6] V. Porter, *op. cit.*, p.128; for translation of the 'Amiriya inscriptions, see Y. Al-Nasiri, V. Porter, "*The Amiriya inscriptions*", in The Amiriya in Rada', The History and restoration of a sixteenth-century madrasa in the Yemen, by Selma Al-Radi, Oxford Studies in Islamic Art, XIII, Oxford University Press, 1997, pp. 203-206.

[7] On this subject, see E. Panofski, Il significato delle arti visive, Torino 1962, pp. 59-106.

[8] For a summary of the regional procedures described in painting treatises, see Mora, P, Mora, L, Philippot P., La conservazione delle pitture murali, Bologna, 1999, chap. V "Le grandi tappe storiche della tecnica" pp. 85- 167.

[9] Z. Veliz, Artists, Techniques in Golden Age Spain, Cambrich 1986.

[10] For a detailed analysis of treatises and documents that attest to a division of labor in wall-painting worksites, see B. Zanardi, Giotto e Pietro Cavallini: la questione di Assisi e il cantiere medioevale della pittura a fresco, Milano, 2002, pp. 39-54.

[11] See Selma Al-Radi, op. cit, pp. 167-171. This chapter is of great interest because it describes how ancient traditions are still alive in Yemen. They involve "workshop" training in the various craft sectors, the passing of know-how from father to son, a rigorous and hierarchical organization of work, and a focus on the division of tasks according to specialization.

Chapter 4
THE CONSERVATION TREATMENT

Chiara Zizola

Condition

The conservation events that have affected the paintings in the Amiriya *madrasa* can be \reconstructed through an analysis of the forms of deterioration found on the wall support and surfaces. Nonetheless, the lack of documentation and reference photographs of the paintings prior to 1982 do not permit us to formulate a chronological picture of its history and conservation.

Despite this drawback, we do know of some basic events that have compromised the integrity of the work, setting off secondary mechanisms of decay, which feed upon themselves in an exponential cycle of cause and effect.

It is well known that the Amiriya *madrasa* is built in an area of high seismic risk, and the most recent earthquake was particularly intense. It happened in December 1982, when the first restoration work on the building had already begun, and affected the region of Radà and Dhamar[1].

Violent earthquakes must have occurred over the centuries up to the period when the building was constructed, as attested by the sixteenth-century chronicles written by some religious judges for the court of the reigning sultans. One draws the same conclusion from the restoration activity involving mosques and *madrasas*, initiated by that same sultan – ‘Amir ibn ‘Abd al-Wahhab (who commissioned the work in the Amiriya) – in the regions of Zabid, Ibb and Tarim during his brief reign.

Furthermore, we know from photographs of the Amiriya taken early in 1900 and in 1910 by Hermann Burchhardt, that at the beginning of the last century the building was in a serious state of decay[2], with cracks in the masonry and the highly obvious collapse of some architectural elements and the external facing. In particular, in the prayer hall, the photos show clear signs of cracks in the domes, which were patched up with a white material, presumably plaster or lime. Though one cannot pinpoint exactly when the history of deterioration began, it is reasonable to suppose that seismic movements over the centuries had undermined the building’s solidity from the start, gradually adding up their destructive impact – first on the structures and then on the external facings, and then on the decorated surfaces. From the consolidation work on the foundations, we also know that the building had been affected by particularly heavy structural subsidence on the eastern side[3].

Analysis and phenomenology of damage

Paintings in general, and wall paintings in particular, are by their very nature composite physical structures, being formed by a support, preparation layers and the paint

surface – elements that differ one from the other. The condition of the surfaces is, therefore, strictly linked to the condition of the support, which plays a primary role in influencing the deterioration of the elements that make up the painting proper, both through damage to its structure and by the nature of its materials and the way they were put together.

50 Pre-consolidation of the precarious fragments with application of cotton gauze.

For this reason, we will analyze the various deterioration phenomena found, beginning with the wall structure and the rendering, and describe the direct effects produced on the painted surface, which is the last layer in contact with the environment. On that surface, one sees the cumulative damage arriving from the interior and exterior of the structure on which it lies – the architecture. We might also add that the very nature of the painting and its materials (pigment and binder) gives it poor resistance over time, especially in a damp environment.

The forms of alteration found on the painted surfaces can be summarized as a combination of the following events[4]: earthquakes; chemical and physical interaction of constituent materials with the environment; vulnerability and physical incompatibility of the constituent materials; damage involving visitors and their deliberate or involuntary actions perpetrated on the surfaces; natural ageing of the original materials (Tables 1-4).

Wall support and preparatory layers

Phenomena mainly linked to the destructive action of earthquakes were found on the support and the plaster layers, subsequently exacerbated by heavy water infiltration from the roof and windows. Earth movements are behind the following damage: cracks and breaks in the wall structure and in the stratification of the plaster, with weakening near the arches; detachments of varying extent of fragments of plaster from the support; lack of adhesion of the plaster to the support and between the preparation layers; *lacunae* [losses] in the plaster.

Signs of settling were found inside the prayer hall: in the central crack, in the downward subsidence of the arches (highly accentuated in the west arch of dome 1), and in the cracks in the plaster, which are generally parallel and run vertically or diagonally. The cracks are found on the walls above the arches, corresponding to the position of the columns, in the center of the blind arches and around doors and windows. Where these cracks are present, there were often losses of plaster, which exposed the underlying wall. In dome 4, in the arch that separates it from dome 3, one could see that the cracks had also affected the wall structure and broken the bricks of which it is made.

Numerous vertical and horizontal cracks were present in all the domes, where 90% of the plaster was completely detached from the wall support and about to fall off. In fact, the greatest loss of plaster was in the domes, and was most extensive in domes 5 and 3. In general, the parts most affected by cracks, detachment and subsequent loss of plaster were the northern and eastern sides of the hall.

The distribution of the cracks, their orientation and the shape of the detachments lead one to suppose that, apart from being shaken, the structure also experienced a dangerous action of compression, so that the plaster in detached parts was swollen and had loose fragments sticking outward.

Moreover, the plaster's sensitivity to telluric shocks was amplified by the fact that it was applied over a layer of clay that covered the bricks. As the clay is plastic and dusty, it did not permit the plaster to adhere perfectly to the masonry.

Once the structure was destabilized and routes for water infiltration had opened up, the deterioration of the paintings was irreversibly accelerated, and led in time to inevitable degeneration of their condition. Probable cracks in the roofing of the domes, originally done with a lime-based mortar called *qudad*[5], led to a particularly aggressive water infiltration over the paintings, which are naturally fragile if exposed to moisture. In all the domes, there were virtually streams of rainwater coming from the roof. Apart from undermining the static situation of the plaster by causing erosion of the clay layer beneath it, they also in time washed over the paint layer and cancelled it in their path.

Even in early times, the rainwater drainage from the roof did not work well. This phenomenon is probably due to the fact that the roof at the base of the domes was (and still is) insufficiently slanted, combined with the settling of the building. Possible confirmation of this hypothesis might derive from an evident painting restoration done in dome 1 in an area that was subsequently affected by more infiltration. We do not know who did this re-painting or when, but it is particularly significant because it points to the existence of a water infiltration problem in the past, in areas that then lost their paint layer. Even after the restoration of the building and repair of the external rendering, these areas continue to suffer the effects of infiltration, due to the inadequate slant of the roofs and the lack of a drainage system to collect the rainwater and channel it away from the external walls. Without such a system, the rainwater (which is particularly abundant in the monsoon season) collects in the lowest areas of the roof, and where it overflows, it wets the outside of the walls, causing absorption by the masonry. In the past, this phenomenon affected all the domes; now it is found in dome 1, 5 and 6.

To summarize, we can say that water infiltration caused not only the detachment of the plaster (already loosened by telluric shocks) by flowing over and eroding the clay on the masonry and between the bricks, but also the onset of physical deterioration processes, when flowing directly over the painted surface.

Paint layer

Water in all its forms is one of the principal factors that triggers deterioration in the painted surfaces. In the paintings of the Amiriya *madrasa*, the mechanical damage due to its contact with the surface was associated with chemical damage as well. On the one hand, the latter was due to the partial dissolving of the calcium sulfate in the plaster, and, on the other hand to the mechanism of dissolving and crystallization of soluble salts in the constituent materials of the structure and the plaster, and in the water itself. This phenomenon was principally found in the domes, where there was more moisture and where there were frequent variations in temperature, caused by the effect of rising hot air currents. This caused the salts to migrate to the surface and crystallize, and the pressure of the crystals led to the progressive decay of the paint layer and the thin plaster layer beneath it.

Indeed, the thin plaster layer showed all the levels of deterioration found in the paint layer itself, from the lightest to the most serious that brought the material back to its original, uncombined state; decohesion; flaking (exfoliation); complete pulverization of the color; and *lacunae*.

In areas of water seepage, there were also extremely tenacious deposits of calcium carbonate; they were a yellow brown color due to absorption of mud and dust in the crystalline precipitate. The extent of the damage – due to a process that normally evol-

ves over a long time – leads us to conclude that the hall was subject to water infiltration going far back to the remote past.

Also due to moisture, there was permanent chemical alteration of some colors at the points of infiltration, with a tendency to blackening: the variation of white to grey is very clear where there was heavy water infiltration; the blue turned to a reddish-grey, probably because of alteration of the white mixed with it. The white (composed of basic lead carbonate) is subject to blackening when it is chemically transformed into black lead dioxide.

A problem shared by all the surfaces is the general loss of cohesion of the color, due to the natural ageing cycle of the binder and the progressive loss of its adhesive and cohesive properties. This natural tendency is generally conditioned by the original working, during which one can produce the conditions for an acceleration of the process, which is slow and cumulative in itself.

We can attribute the differences found in the condition of the color on entire walls to the greater or lesser dilution of the binder used to make the pigments adhere to the plaster. The latter situation applies to the south and west walls over the arches of dome 2, and the whole painted register over the doors, where the color is mostly lost – also because of its greater exposure to erosion caused by atmospheric particulates and the impact of human activity.

In fact, the constant use of the hall for religious purposes is at the root of numerous alterations in the surfaces of the lower parts of the walls.

Scratches, abrasions and even incisions in areas accessible from below were also produced in attempts by inexpert hands to clean the surfaces with unsuitable tools. It is also likely that dusting the walls abraded the more superficial painted areas and led to loss over time.

Thick layers of whitewash, normally used to disinfest and clean the surfaces, covered entire painted areas above the stucco decoration. Usually thrown from below to paint the stuccos[6], this layer also eventually covered painted areas up to a height of about a meter above the stucco band, paradoxically preserving the color from environmental aggression.

The oily-resinous deposits blackening the surface can be attributed to the smoke from oil lamps used to light the hall; these are particularly heavy in dome 3. Centuries-old layers of dust (which had compacted over time), spider webs, atmospheric particulate borne by the wind and mud washed from the structure obscured all the surfaces, especially in protruding elements, giving the paintings a dilapidated, dull appearance that hid the chromatic and decorative richness of the cycle – now fortunately rediscovered.

The absence of restoration treatment of the surfaces, except for the retouching in dome 1, allowed these paintings to come down to us in a relatively unchanged condition as to their decorative essence, damaged only by the various events that affected the monument as a whole. Thus we are able, 500 years after their creation, to restore

them to their place in history, without disturbing their originality but preserving all their artistic, technical and material information for posterity and for the critical review that goes hand-in-hand with the study of art history.

Technical treatment

Every conservation treatment is studied and planned on the basis of the work's material and technical identity and on an in-depth knowledge of the deterioration mechanisms and damage found. It is composed of direct and indirect activities, conceived to arrest or slow down the decay mechanisms at work, prevent others from arising and re-establish conditions of equilibrium with the environment. The aim is to prolong the life of the original materials, enhance visitor enjoyment and allow the artistic, historical and spiritual message they convey to move through time in a slow, progressive ageing process.

Given this premise, one can state that the necessary condition to favor the work's passage through time lies not so much in the direct operations on the work itself (albeit necessary and inescapable), but in the continuous care that is called into play only when the work maintains its daily functions. In other words, where the architecture and decorations continue to have community value and are collectively considered irreplaceable, one can establish conditions for their continuous upkeep. Maintenance is indispensable and cannot be separated from the technical operations currently being performed on the monument and its surfaces[7].

The treatment of the wall paintings of Amiriya was, therefore, composed of activities such as consolidation, cleaning and pictorial integration, together with training of local technicians for future maintenance of the surfaces, developing a maintenance program, and also promotion of information. It is hoped that these activities will permit the Amiriya to return to the flow of history, benefiting from the care required by its fragile and ancient structures.

Direct conservation treatments

The treatment of the painted surfaces and their support was aimed at reinforcing the materials, reclaiming their function and improving the legibility of the whole and of individual decorative areas. The materials and techniques used in the treatment were modulated on the basis of the original constituent materials, as well as the type of damage and alteration products found on the surfaces.

We will describe here the methodologies adopted, explaining the reasons for the choices made and listing the materials employed. This approach will provide a sort of user's manual, making available all the information necessary for future treatments of surfaces with the same technical characteristics, and for implementing the maintenance program for the Amiriya paintings in the near future.

It must be stressed in this context that every intervention, whether direct conservation or maintenance, involves in itself a modification of the original, and it is thus exceedingly important (before touching the works in any way) to have full knowledge of the original materials, of their chemical and physical behavior, and of their state of health. In-depth knowledge of the materials used for treatment is also vital in order to predict the effects and guarantee compatibility, efficacy and stability over time.

Fixation of loose fragments

To prevent the fall of loose plaster fragments, the affected areas were temporarily anchored to the solid surfaces around them. This operation is generally performed to allow the operators to proceed safely with subsequent operations of consolidation or emergency repairs of damaged surfaces, while waiting for further conservation treatment.

The surface to be treated is dusted with delicate jets of air and – where possible without compromising the stability of the fragments – through very light brushing with marten brushes. Then a bandage of cotton gauze is applied to the surface with an acrylic resin as an adhesive: Paraloid B72 dissolved in acetone at 15%.

The choice of adhesive was determined by the need to use a non-aqueous material that could adhere to the surface without interfering with the paint layer, which is particularly sensitive to water. The solvent used evaporates quickly and is low in toxicity. It limited the adhesive from penetrating into the lower layers, thereby facilitating the subsequent operations of removing the bandage itself and the adhesive (Fig. 50).

Pre-consolidation of the paint layer

Where the paint layer was loose, powdering or flaking, it was first consolidated before undertaking any other operation. The phenomenon of decohesion and powdering of the paint layer is principally due to the loss of the binder that originally united the particles of color. Therefore, the treatment was aimed at restoring cohesion to the powdering color by spraying the surface with a 3% solution of Paraloid B72 in acetone or – in less serious cases – brushing it on. The resin is absorbed by the paint layer, and by capillarity by the underlying plaster layer. Once the solvent dried by evaporation, the resin re-established the lost links and gave structural consistency to the color without modifying its optical properties.

Where there was flaking of the paint, i.e. where the paint layer was detached from its support, the treatment was to make the fragments re-adhere to the underlying plaster with localized injections of an acrylic resin emulsion having high adhesive power: Primal AC33, dissolved 10-15% in water. The impregnation was performed by injec-

ting a few drops of adhesive beneath the flakes. Through a layer of polyethylene, a spatula was then used to press the fragments together and against the plaster below, re-establishing the lost adherence (Fig. 51).

In performing these operations on wall paintings, one must rule out all traditional materials (such as animal glues and egg) because even though they belong to the nature of the paintings themselves, they do not possess the necessary qualities of reversibility, stability and resistance to chemical and biological deterioration. When used as consolidants or fixatives – i.e. when applied over the paint layer – they can feed the development of highly dangerous alteration processes, which are frequently irreversible.

51 Consolidation of detached color from the surface of the plaster with infiltrations of acrylic resin.

52 Dusting of the surfaces.

Cleaning

In every restoration treatment, the cleaning of the surfaces is the most delicate phase, and the one that can most greatly affect the future conservation and intrinsic qualities of the paintings. In fact, the cleaning of a painted surface reveals the current condition of the original materials as they have come down to us over centuries of history, but in no way can it re-establish the original condition of the paintings. By its very natu-

re, this operation is irreversible and must be limited to removing the alteration products that obscure or damage the surfaces, using the most suitable means without attempting to bring the colors back to their original splendor. Therefore, one must neither impair the constituent material nor the irreversible transformations that this material has undergone over time and that determine its aesthetic reality today.

These transformations are due to the natural ageing of the materials as they interact with the environment (effects of light, moisture, atmospheric dust), and they become either an integral part (as a patina) or a permanent alteration of the painted layer and its support. From the strictly conservationist point of view, maintaining these transformations as patinas assures a surface protection of the painting that is completely natural because it was produced by the painting itself. Without a patina it would be more at risk of accelerated ageing with unpredictable results.

Cleaning, therefore, is an operation to be performed exclusively as a function of selective and progressive removal – starting at the surface and up to the altered paint layer – of substances that are extraneous to the surfaces, using specific methods and materials depending on the substance involved. As far as possible, the materials used should be inert in relation to the original ones.

The nature of the Amiriya paintings, which are highly susceptible to water in general and even more so in areas already struck by infiltration (as per the processes described above), calls for the preferential use of dry, mechanical cleaning systems. This applies both to the removal of loose surface deposits (mud, salt efflorescence, dust) and to removal of more stubborn deposits, such as the dust embedded in slightly greasy layers. Therefore, all the surfaces were first dusted with marten or soft-bristle brushes, while drawing up the deposits removed at the same time. Where the color was more resistant, the brushing was repeated in order to permit a deeper initial cleaning with the most delicate system available (Fig. 52).

This cleaning phase was followed by cleaning with Wishab sponges (Fig. 53), restricted to the places where more stubborn dust layers remained. The combined action of the brushes and sponges satisfactorily removed most of the deposits, assuring a homogeneous and relatively balanced presentation of the surfaces in all the domes except for those with lampblack or carbonated layers. For the latter areas, it was necessary to use chemical cleaning to dissolve the deposited substances by breaking their chemical bonds so that they could then be removed mechanically.

Deposits of lampblack (produced by the fumes of the oil lamps and candles used to light the space) obscured the paintings principally in the central domes, affecting the walls, under arches and domes themselves. A weakly alkaline solvent mixture (equal parts of ethyl alcohol, ammonia, acetone and water), was repeatedly applied through paper tissues and left to work for a few moments, softening the layer. It could

then be removed or lightened with subsequent blotting with cotton balls soaked in the same solvent. This mixture, which has a weak solvent action due to the volatility of the main ingredients, was chosen in preference to stronger solvents because it allowed the work to be kept under constant control. This approach avoided the danger of impoverishing the color (already weak in itself) or driving the dirt deeper into the porous structure beneath (Fig. 54).

53 Cleaning of the coherent deposits with Wishab sponges.

The cleaning of the carbonated incrustations, found in areas affected by water infiltration, proved to be more problematical. Here, the deposits were formed by precipitations of calcium carbonate and contained atmospheric particulate and clayey fragments in their crystalline structure. As they were more tenacious than the underlying materials, it was impossible to remove them without putting the painting and plaster themselves at risk.

Restricting ourselves to areas without any paint or preparatory design, we proceeded to lighten the superficial chromatic alteration, using poultices of a weakly alkaline solution of ammonia and EDTA, dissolved in water in proportions of 30 g/lt and 25 g/lt respectively. The solution was applied in paper pulp for 15-30 minutes. After the mixture had had time to work on the surface of the incrustation, it was possible to remove part of the grey-brown deposits it contained, removing the poultice and repeatedly rinsing the surface with water and scrub brushes. In most of the areas involved, it was not possible to completely remove the incrustations, which will stay permanently on the surfaces.

In the lower zones of the walls with whitewash, it was sufficient to remove it mechanically with scalpels, gradually scraping it away until it was completely gone. The layer was usually softened beforehand by applying a mixture of equal parts of water, alcohol and acetone. Not surprisingly, the color tones were more consistent and lively beneath the layer, because the whitewash had inadvertently protected them from the environment for many years (Fig. 55).

54 Chemical cleaning of the deposits of lampblack.

55 Removal of the whitewash by using a scalpel.

Consolidation of the paint layer

At the end of the cleaning, all the surfaces, except for those already treated during pre-consolidation, were consolidated with Paraloid B72 in a 3% solution, as described in the paragraph on pre-consolidation. The paintings' extreme sensitivity to moisture suggested it would be wise to protect the color before consolidating the plaster, as that calls for water both for making the consolidating mixture fluid and able to penetrate deeply, and for the preparatory phases of internal cleaning of the areas being treated. Moreover, this layer isolated the original painting from later pictorial reintegration, and would facilitate removal of the retouching in the future, if necessary (Fig. 56).

56 Consolidation of the pulverized colour with vaporized acrylic resin.

Consolidation of player detachment

This operation is necessary whenever there is detachment between the plaster layers and between the plaster and the wall, with the formation of empty pockets inside – i.e., areas missing the constituent materials of the layers themselves or areas that had been deformed and lost their original adhesion. These phenomena were widespread in the wall-painting cycle at Amiriya, and had led to the loss of entire sections of the painting over the centuries. They were caused by seismic shock and wetting of the mud layer in direct contact with the masonry, when the water coming from cracks in the domes found its way inside the walls.

Every type of detachment calls for a different consolidation procedure, which differs principally in the consolidating material used and according to the extent of detachment involved. In all cases, however, the areas to be treated must be cleared of dust and detritus by various means: mechanically through vacuuming or air jets where they can be used; or chemically through injection of a mixture of ethyl alcohol in water, which fosters good penetration of the consolidant and anchorage to the surfaces.

To limit the amount of water used overall inside the masonry and facilitate rapid evaporation, the cleaning of the zones being consolidated was done by injecting an 80% mixture of ethyl alcohol and water.

In the case of superficial detachment between plaster layers, the consolidation is limited to restoring the lost adhesion through injections of materials with adhesive properties; once they dry, they form a chemical and mechanical bond between the detached surfaces.

For this type of detachment, which is generally of limited extent, a 25-50% solution in water of Primal AC33 was used. Once the area was identified through light manual tapping of the surfaces, the adhesive was injected inside with a syringe, through pre-existing cracks or lacunae or by making small entry holes with a hand drill, preferably in places where the color was gone.

Consolidation of detachments between the plaster and the support (sometimes quite severe) requires a more complicated treatment and the use of a consolidating material that acts as both an adhesive and a filler. Once the mass has solidified, it reintegrates the lost materials. Pre-mixed hydraulic consolidants specifically formulated for this field of application were used for this purpose – PLM-A and PLM-vaults. They are composed of hydraulic lime, inert filler and additives that improve their adhesive properties and penetration (Fig. 57).

57 Consolidation of the detached plaster with injections of hydraulic consolidant.

Based on the extent (width and depth) of the detachment, the injections were done with great caution in order to avoid having the weight of the consolidant cause a final collapse of the plaster in zones that were already barely attached. Braces were applied during the process to support the zones being consolidated, and the work proceeded from the lower zone of the detachment, gradually moving upward. Intervals of 24-48 hours were observed between one infiltration and another, to permit partial solidification of the consolidant and the progressive anchorage of the surfaces.

The zones reached by the consolidation were easily seen on the surface, due to the water that dampened the plaster. Although this provided perfect control of the operations, yellow stains also appeared at the edges of the consolidated areas when the painted surfaces were drying – probably due to the surface migration of pigmented particles contained in the underlying mud. To remove them, repeated applications of paper tissues soaked in ethyl alcohol were used, waiting for the tissue to dry completely between one application and another.

In domes 3 and 5, some loose fragments of plaster had to be temporarily removed because they were so detached from the support that infiltrations were not possible. The removal was done by glueing cotton gauze over the surfaces and then separating the plaster sway from the few places still attached. After that, the empty spaces between the bricks of the support were stuccoed and the fragments were reattached to the wall with a mortar of lime and pozzolana. The gauze applied during preconsolidation and for the removal was removed after consolidation with poultices of cotton soaked in acetone.

Stuccoing of lacunae

From a strictly conservation point of view, the stuccoing of *lacunae* in the plaster and other breaks and cracks is a preventive operation to avoid mechanical damage caused by the difference of levels in the painted surface, which react differently to external and internal stress. Accumulated dust, insects and other small animals are also removed in the process. In addition to this function, the stuccoing of wall paintings also has an aesthetic – or optical – function in recomposing the formal unity of the work.

Lacunae in the plaster represent a permanent loss of the original material, and thus they cannot be reconstructed. Although one cannot recover something that no longer exists, it is still necessary to reduce the optical disturbance that these losses produce in the overall effect, sending them to the background of the painting that remains. To obtain this effect, the *lacunae* are stuccoed below the level of the painted layer, with a material similar to that of the original plaster, so that it looks like they are due to the

loss of the final painted layer, which had exposed the surface beneath. In this way, the appearance of the *lacunae* corresponds to the structure of the painting and suggests, through an optical effect, a reading of the painting from below to the upper surface. This approach helps to make the painting emerge from the ground, which has been reconstituted as a uniform plane.

In order to achieve this effect of a reconstitution of the optical background plane and material "behind" the painting, the *lacunae* must be stoccoed with the same type of mix, using a color and consistency that agree with the original and working at the same lower level.

This principle was applied when doing the extensive stuccoing in domes 3 and 5, where considerable loss of the original plaster had exposed the masonry of the support. The *lacunae* present in all the other domes, filled with the same mix, were of smaller dimensions. The mix used was composed of slaked lime, hydraulic lime, gypsum, river sifted sand in water, in a proportion of 1:1,5. It was spread on a previously dampened surface and worked for a long time to assure the necessary adherence to the masonry (Fig. 58).

58. Filling of the lacunae of the intonaco with lime mortar.

59. Filling of the fractures with gypsum based mortar.

A different approach was chosen for the integration of small *lacunae*, perhaps a few centimeters across, caused by the loss of the final plaster layer on which the painting was done, particularly if they were in a context that could be integrated with painted retouching. These stuccoes were done at the level of the original plaster with a gypsum mix and then retouched with watercolors (Fig. 59).

Pictorial integration

The same principle that guided the filling of *lacunae* in the plaster influenced the decision to integrate *lacunae* in the paint layer, abrasions and spot losses of color. As these revealed the white of the plaster beneath, they impeded the reading of the overall work because they stood out optically against the tone of the intact painting[8].

Watercolors were used for this purpose, applied on surfaces that had previously been protected with acrylic resin. The watercolors are a different material than the original paint and can thus be recognized close up. Moreover their transparency and complete reversibility are vital characteristics for the pictorial integration treatment of wall paintings, especially if used on the original plaster.

60 Dome 1 during the pictorial retouching.

61 Dome 1 during the pictorial retouching.

Given the extent and variety of the *lacunae* found, it was necessary to adopt different types of integration in order to recover as much as possible of the original decorative texture and enhance the colors. One category was the *lacunae* that could be inte-

grated by reconstructing the missing motifs, which could be interpreted because they were repetitive. Another category was the *lacunae* that could not be integrated because they were too large and would have meant a general falsification of the paintings. The paint *lacunae* on the inscriptions, no matter how extensive, were completely reconstructed for purposes of worship[9] (Fig. 60).

62. Dome 1 during the pictorial retouching.

Lacunae surrounded by well-conserved painting were thus integrated by reconstructing the missing motif, leaving a light undertone of the color which permits the treated area to be easily recognized on close inspection. More extensive *lacunae* were treated with a ground color that goes well with the general tones of the surrounding painting, thus creating a uniform plane behind the remaining colors and facilitating the emergence of the forms.

Abrasions and spot losses of color were integrated with inconspicuous glazing, which re-established continuity and depth to the tones. Otherwise they were difficult to read and highly fragmentary (Fig. 61-62).

The most complex recovery was that of the decorated register above the doors, where the extreme consumption of the color – throughout the room – interrupted the decoration in a disturbing way and impeded a proper reading of the spatial relationships of the architecture. Nonetheless, the original plaster exposed did allow traces of the original drawing to emerge, together with the faded imprint of the color. Consequently, it was decided to recover the drawing by heightening the tone of the traces of color, with highly transparent and watery glazing, which now assists the reading of the otherwise illegible original decoration. The intervention can immediately be recognized by the pastel tones used, and permits both the reading of the original decoration and a balanced chromatic connection with the decorations above, which are rich in color, re-establishing the formal relationships between architecture and decorations.

63. A course participant documents the state of conservation of the painted surfaces.

Maintenance program

The future conservation of the monument now rests on the performance of a series of activities to check and maintain the structure and the surfaces. Through simple operations, carried out periodically and regularly, the benefits obtained through the restoration treatment can be maintained, and the life of the monument as a whole can be prolonged.

The maintenance activities will be entirely supervised and performed by the technicians from the Department of Antiquities who worked side-by-side with the conservators during the treatment and gained experience in the principal techniques of cleaning and consolidation. The main activities will involve dusting the surfaces, checking the efficiency of the external rendering and rainwater drainage, and monitoring the surfaces to verify their condition.

The maintenance plan includes ordinary treatment on a yearly basis by six technicians from the Department of Antiquities. The following technical operations will be involved:

- Setting up the mobile scaffolding and preparation of materials and equipment;
- Removal of loose deposits from the surface with marten brushes and suction;
- Revision of the treatments (state of the stuccoing and substitution of any deteriorated parts; revision and control of the consolidated areas);
- Control of the surfaces to identify deterioration phenomena in progress (water infiltration, appearance of soluble salts, presence of new detachments or cracks, blistering of the paint layer);
- Documentation of the conservation condition and the treatments carried out.

64? The course participants experiencing the pictorial retouching.

The maintenance of the surfaces should be accompanied by the ordinary maintenance of the building. It will be important to: clean the hall regularly, using vacuum cleaners to avoid further deposition of dust on the painted surfaces; make sure the doors and windows close properly; and immediately repair any damage to the mortar covering the domes. In particular, checking the condition of the roofing and any repairs needed should be done twice a year, near the rainy season (Fig. 64-65).

NOTE

[1] See Selma Al-Radi, "*The Restoration of the Amiriya*" in this volume.

[2] Photos published for the first time in The Amiriya in Radà, The History and restoration of a sixteenth-century *madrasa* in the Yemen, by Selma Al-Radi, Oxford Studies in Islamic Art, XIII, Oxford University Press, 1997.

[3] See Selma Al-Radi, "*The Restoration of the Amiriya*" in this volume.

[4] On the causes and mechanisms of deterioration and alteration products, see Gaël de Guichen, *Diagram on the causes of deterioration of Heritage*, in, Youth and the Safeguard of Heritage, edited by Alice Blondè, ICCROM, Rome 2000 p. 19; Fattori di deterioramento, Corso sulla Manutenzione di dipinti murali, mosaici, stucchi ; DIMOS, parte II-1, ICR Roma 1979; P.Mora, L. Mora, P. Philippot, La conservazione delle pitture murali, Roma, 1999; G. Torraca, Porous building materials, ICCROM, Roma 1986.

[5] Selma Al-Radi, op. cit.

[6] See Selma Al-Radi. Probably this layer was originally applied to combat an infestation of Coleoptera [beeetles] coming from the carpets that covered the floors. When the whitewash on the stuccos was being removed, a large number of larvae were found in the cavities.

[7] See the contribution by Selma al-Radi in this volume for a description of the treatments performed on the building.

[8] On the theoretical principles and the issues involved in treatment of lacunae in wall paintings, see P. Mora, L. Mora, P. Philippot, La conservazione delle pitture murali, Bologna 1999, pp. 329-345

[9] Thanks to the training course participants from GOAM for their assistance in reading the passages from the Koran and in reconstructing the missing or fragmentary letters.

[10] G. Urbani, Intorno al restauro, edited by B. Zanardi, "*Strumenti tecnici per una politica di tutela*", Skira ed., Milano 2000, p. 61.

PLATE OF THE DETERIORATION PHENOMENA - 1

COLOR ALTERATION

COLOR ALTERATION

CARBONATE DEPOSITS

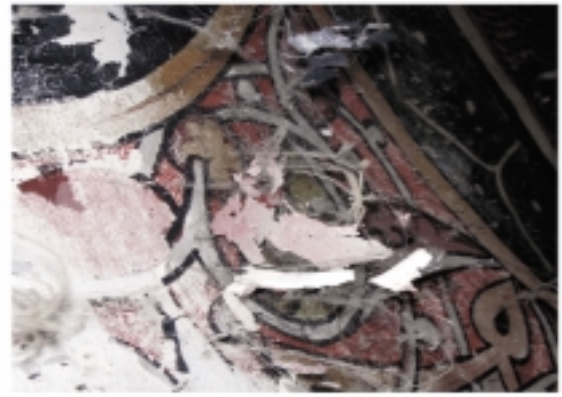
CARBONATE DEPOSITS

DUST DEPOSITS

DUST DEPOSITS

PLATE OF THE DETERIORATION PHENOMENA - 2

BLAK DEPOSITS OF SMOKE



SPIDER WEBS AND DETACHMENT OF COLOR

GYPSUM WHITE WASH

UNPROPER CLEANING

LOSSES IN THE COLOR DUE TO WATER INFILTRATION AND DEPOSITS OF MUD

PLATE OF THE DETERIORATION PHENOMENA - 3

DETACHMENT OF INTONACO

DETACHMENT OF INTONACHINO

DETACHMENT OF INTONACO

LOSSES IN THE PLASTER AND CRACKS

LACUNE, CRACKS, BREAKS

PLATE OF THE DETERIORATION PHENOMENA - 4

FLAKING OF COLOR AND DECOHESION OF THE INTONACHINO

SUB-EFFLORESCENCES

CRYSTALLIZATION OF SOLUBLE SALTS

ABRASION OF THE COLOR

Winsor & Newton Watercolors

These are used in the restoration of works of art because of their stability and the quality of the components. The pigments are ground with water and gum Arabic.

Acetone

Low-toxicity organic solvent for synthetic resins, natural rubber, cellulose and its derivatives. It belongs to the kethone family.

Ethyl alcohol

A highly volatile polar solvent, low in toxicity, for some substances contained in the natural resins of plant gums and shellac. It belongs the alcohol family.

Ammonia

A highly soluble gas used in a water solution, forming ammonium hydroxide. It is a good solvent for greasy, oily substances. As it is a gas, when the water portion evaporates it does not leave residues on the surface.

Ammonium carbonate

Ammonium salt. When dissolved in water it forms a weakly alkaline solution which acts to swell fatty and proteinaceous substances. In time, it changes to gassy compounds and thus does not leave residues on the surfaces.

Hydraulic lime

Hydraulic lime can set in water and where there is little carbonic anhydrite. It is thus useful as a binder in consolidant mixtures, guaranteeing that the mass will set and harden even deep within a wall. It is obtained by firing marly limestone (containing clay), at 950-1100°C or by artificial means, firing mixtures of limestone and clay. In fact, it is the clay that gives the lime hydraulic properties through the hydration of calcium silicates and aluminates and formation of crystalline substances.

E.D.T.A

Disodic salt of ethylene-diamine-tetra-acetic acid, which combines with calcium so it can be dissolved.

Solvent mixture based on alcohol, ammonia, acetone and water

Combines the solvent properties of alcohol and acetone for resinous substances with ammonia's ability to remove greasy materials. The addition of water makes the mixture less volatile and controls its evaporation.

Paraloid B72

Synthetic copolymer composed of ethylmethacrylate and methacrylate, soluble in organic solvents, colorless. It has good resistance to ageing and water, stability under light, reversibility, transparency. Given its characteristics, this resin is widely used in the field of restoration of works of art, and is used as an adhesive, consolidant or protective layer, depending on the concentration and solvent employed.

PLM-A

Pre-mixed hydraulic consolidant produced by CTS Vicenza, Italy. Contains 50% Lafarge hydraulic lime, quartz (principally) as inert filler, and synthetic polymers with adhesive and fluidifying functions.

Paper pulp

Cellulose fiber available in various sizes, with high absorption power. Used in poultices to bring solvents into contact with the paint surface and limit their being absorbed by the layers beneath.

Primal AC33

Acrylic resin in emulsion, with excellent adhesive properties, high resistance to ultraviolet rays, permanent flexibility, elasticity and solubility in organic solvents, even after prolonged ageing.

Wishab sponges

Special sponges for cleaning paintings and paper artifacts, composed of a soft yellow material, similar to chamois. It is made from synthetic latex, mineral oil and chemical products for vulcanizing and gelling, supported by a rigid base.

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Index of photographic catalogue

Photos by Araldo De Luca/Archivio CCA

Printed in Italy
by Arti Grafiche Nobili Sud
May 2005