THE SAFEGUARD OF THE ROCK-HEWN CHURCHES OF THE GÖREME VALLEY

Proceedings of an International Seminar

ICCROM

Ürgüp, Cappadocia, Turkey
5-10 September 1993

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For technical reasons, some characters in the Turkish alphabet could not be given in the names of people and places. We apologise in advance to our Turkish readers and others who will note their absence.

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FOREWORD

Considering the importance of the World Heritage Site of the Göreme National Park and the Rock Sites of Cappadocia, together with ICCROM's involvement in the area for 20 years, it may be useful to summarize some of the main issues before reporting on the actual seminar.

The Göreme Valley is a part of Cappadocia in central Anatolia, Turkey, where about 10 million years ago active volcanoes formed 100-150 metre-thick layers of tuffs of varying hardness and including scattered basalt blocks. Due to the effect of water and climate, these plateaux have eroded to conical rock formations of great variety. The erosion is a continuing process: a surface tested recently had lost 20 mm in 6 years.

The region has a rich cultural past, from the Neolithic age (ca 7th millenium BC) to the Hittites , through the Persians, the Kingdom of Cappadocia, the Romans, to the Byzantine (AD 397-1071) and Seljuks. At least since Roman times, dwellings and even entire underground towns have been carved in the rock. The numerous Byzantine churches are especially important for their beautiful mural paintings. Eroded rock formations and cave constructions are found in an area that measures about 100 km in length, within the jurisdiction of four provinces of the Cappadocia Region. Several modern towns and villages include rock-cut settlements. Due to dangerous structural conditions, many cave areas were appropriated by the State in 1952, and the inhabitants moved to new dwellings.

Earlier management action in Cappadocia

French explorers gave some of the earliest descriptions of these fairyland-like geological "chimneys" in the eighteenth and nineteenth centuries. Since then, the region has held special interest for visitors, and since 1955 some areas have been protected as "open air museums." The Göreme Valley was designated as a National Park, and a draft Master Plan was prepared for its conservation management.

In 1986, UNDP provided a fund for conservation equipment, but this has been only partly used so far. In 1990, UNDP sponsored an international seminar on "Promoting, Preserving and Prospering Turkish Cultural Heritage." The seminar gave recommendations for management planning in the region, but these have not yet been implemented. In August 1993, a law was submitted to Parliament for the establishment of the management structures first proposed in 1971.

The ICCROM seminar

To provide an international forum for consideration of the current status of the area, the Ministry of Culture of Turkey and ICCROM, with the financial support of UNESCO, organized from 5 to 10 September 1993, an international seminar on "The Safeguard of the Rock-Hewn Churches of the Göreme Valley." It was coordinated by Ülkü Izmirligil and Marisa Laurenzi Tabasso. R. Ozil and W. Schmid, in collaboration with L. Rizzo Vecchio, were responsible for the secretariat. The seminar was inaugurated in the presence of the Minister of Culture of Turkey, the Director General of Monuments and Museums of the Ministry of Culture, the Governor of Nevshehir Province, and other local dignitaries. ICCROM, UNESCO, UNDP and ICOMOS represented the international community, and some 50-60 persons attended. The proceedings are being published with the assistance of the World Heritage Fund.

The aim of the seminar was to evaluate the results achieved after two decades of national and international efforts, and to suggest guidelines for future actions. The aim was also to examine ICCROM's role in the project, and to gather information that could be useful in similar situations in the future.

For these reasons, the international experts who had studied various issues and problems at Göreme since the early 1970s were invited by ICCROM to take part in the seminar. The Istanbul Central Laboratory for Restoration and Conservation, on behalf of the Ministry of Culture, did the same with the Turkish specialists. Other renowned experts with relevant experience were invited as well. The seminar had five working sessions :

	Session	Chairperson
1)	Definition of the Göreme Project	L. van Nispen
2)	Site Management and Cultural Tourism	M. Laenen
3)	Material Analysis	M. Yorulmaz
4)	Structural Stabilization	J. Jokilehto
5)	Conservation of Mural Paintings	W. Schmid

These sessions alternated with visits to the Göreme Open Air Museum, the Zelve Valley and other significant places in the surroundings, in order to acquaint the participants with the current situation.

Following the inaugural session, four working groups were formed in order to discuss various specific problems and to suggest further action in the form of recommendations (see page 203). The recommendations were read in the presence of the Governor of Nevshehir and several mayors, as well as representatives of tourism and the open-air museum, at a final session chaired by J. Jokilehto.

Conservation management of Göreme Valley

Over the past 30 years, visitors to Göreme Valley have increased from 6 000 to 430 000 per year. Particularly in the last decade, the number of hotels has increased even more, and there now appears to be an oversupply of beds. Conservation has been limited to mural paintings and some experimental work on a few churches. The seminar expressed concern for the lack of general management planning in the tourism sector although visitors are increasing and many tourism facilities, hotels, parking areas, etc., have been poorly located in sensitive areas; the local community has been critical about problems in exercising agricultural activities; there is no regular maintenance or repair work in the fragile rock-cut churches, which risk collapse at any moment, with the potential for the loss of valuable heritage – as well as the results of conservation work already carried out during the past two decades.

However, a new law was presented to the Turkish Parliament in August 1993, which was to create an inter-ministerial commission and a local management and planning commission, as well as an advisory board consisting of representatives of the local authority, for the conservation and development of the whole protected area in the Cappadocia Region. This management structure will be the first of its kind in Turkey, and will have reasonable administrative and financial autonomy. This law merits all possible support, but it may still take some time – perhaps several years – before the new management structure will be in functioning order.

In the meantime it is essential to use the existing resources to start implementing measures that are necessary to stop decay at least in the most critical areas. For this purpose the seminar gave technical recommendations.

In the two museum areas visited during the seminar, there was a clear need to plan better integrated management, taking into consideration the whole context. Visitors should be given an understanding of the Cappadocia region, its geology, its history and culture, as well as its artistic qualities. There is also a need to repair and rehabilitate existing historic areas (e.g., houses from the nineteenth century with fine carvings) that are currently abandoned and ruined, or otherwise not properly managed.

It is necessary to initiate programmes to educate and increase awareness in the local population, to train local authorities to understand the significance of their heritage, both natural and cultural, to guide sustainable development, and to fight vandalism. It was observed that ICCROM's *Management Guidelines for World Cultural Heritage Sites* would be a suitable basis for conservation management in this region. The possibility of a Turkish translation of this publication was discussed.

It will be necessary to establish a working group to help make the proposed management structure a reality, and to assist in undertaking any immediate measures that may prove necessary for maintenance and structural consolidation. This group should include representatives from the Ministry of Culture, the local authorities and METU, as well as keeping contacts with international organizations such as ICCROM, UNESCO and the regional UNDP office, which have already worked in the area.

ICCROM has trained a competent restoration team for Turkey, and, at the same time, several important churches of Cappadocia have been restored, two of them under ICCROM's direct guidance and control. Tests have also been carried out to understand the structural and material behavior of the eroding rock structures.

Much still remains to be done, however, and the following needs have been identified:

- prevent the imminent collapse of some important church structures (urgent);
- initiate basic maintenance in the area, and especially in relation to mural paintings (urgent);

- prepare an overall management plan for the conservation and development of the region – including the settlements, tourism services, visitors, traffic, etc;
- establish a system of communication, documentation and inventory;
- educate local communities about their heritage;
- continue training conservators, technicians, operators, managers and administrators; and
- a law to enable all this to happen and regulations to implement it.

Much will depend on the passage of the law and establishment of the management structure. Nevertheless, it is necessary to form a working group now, with the task of laying the groundwork for the management structure, and starting some of the most urgent actions in relation to maintenance and preventive structural consolidation. It is also necessary to initiate a process for collection of data related to the economic development of the community, cultural tourism and global management of resources.

The following developments have occurred since the seminar:[1]

- the law is at the stage where proposals from the different ministries involved in this matter, e.g., Tourism and Environment, are being collected;
- a regional Commission for the Preservation of Cultural Property has been established in Cappadocia since 1995 for taking urgent measures;
- the Master Plan for the preservation of monuments, natural and cultural landscape (scale 1:25 000) has been prepared by the Town Planning Department of Nevshehir; and
- a local team of mural painting experts worked for a month on the documentation and rescue conservation of mural paintings in different churches of the Göreme region in the summer of 1994 and intend to continue this project in 1995.

The responsibility for initiating and carrying out this process will need to be taken by the community with the support of the government. The role of international organizations should be seen clearly as consulting agents who can help in identifying the objectives, assisting in the initial coordination of the work, and advising and monitoring progress. It is also necessary to clearly define the role of training, coordination of research and communication in the process.

M. Laurenzi Tabasso and J. Jokilehto, ICCROM

Editors' note: This publication contains all those papers provided by the authors by mid-1994. They appear substantially as delivered, with light editing for English style and consistency.

1 Ü. Izmirligil (Director of Central Laboratory, Istanbul), personal communication.

GENERAL FRAMEWORK OF CONSERVATION ACTIVITIES IN GÖREME VALLEY, CAPPADOCIA

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ABSTRACT

The paper provides an overview of conservation activities in the Cappadocia Region, at national and international levels, in chronological order from the 1960s onwards. It briefly describes ICCROM missions, National Park activities, the Conservation-Development Project of Ortahisar for 1975 Architectural Heritage Year, the UNDP Structural Conservation Project for Göreme, the UNESCO Campaign to create community consciousness as well as to raise funds for conservation implementations, and activities for nomination to the World Heritage List. The focus of the paper is on the activities of the Ministry of Culture, and mainly covers the period between 1980 and 1985. This emphasis is due to the author's accumulation of information from her role in the UNDP project.

Göreme Valley, an important focal point of the Cappadocia Region, has always been a centre of interest for research in fields such as restoration, history, history of art and architecture, geology, chemistry and others. Such intense interest in the area and its nearby environment is due not only to its richness in natural, historical and architectural values, but also to the variety of problems presented by the whole region. In this respect, there have been, throughout the recent past, a number of missions addressing the problems. This paper aims to provide an overview of activities in the recent past, in chronological order based on the starting dates of the various activities, given that most of them are still continuing.

It should be remembered that the geomorphological nature of the region, which is responsible for the unique characteristics for which it is considered worthy to be preserved by the whole world, is also the cause of deterioration. In brief, survival of the site is endangered primarily by natural causes, such as erosion of the volcanic tuff by air and water.

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Damage and destruction caused by human hands are as important as the wear of time and physical factors. Uncontrolled development of tourism is another danger threatening the whole region. Consequently, erosion caused by human beings becomes more and more extensive and creates a vicious circle: the area has unique characteristics, and has become one of the most important sites in international sightseeing. This creates a rush of tourism, but, again due to the nature of the region, such an over-use causes surface erosion. In addition to this natural erosion, vandalism is also a significant problem. Intentional human damage, in the form of carving, digging or graffiti, mostly afflicts the mural paintings.

If Cappadocia has a universal value worthy of preservation, it should quite naturally be visited, but the resultant damage should be minimized by creating an equilibrium between tourism and preservation. Efforts to accomplish this aim are discussed below.

The earliest organized attempt that covers Cappadocia appears to be the "Göreme Historical National Park" project implemented by the National Park Department of the Ministry of Forestry in cooperation with the U.S. National Park Service Planning Team. The product of this teamwork was the Master Plan proposal for the Göreme Historical National Park, in 1967. This project covered a vast area, including Uçhisar, Göreme (Avcılar), the Göreme and Zelve Valleys, Çavushin, Ürgüp and Ortahisar. Later, in 1971, a revision of this master plan was prepared by a "Park Planning Project Team" constituted in the Ministry of Forestry.

Another early attempt was the international contacts in 1969 for the conservation and restoration of the rock-hewn churches of Cappadocia, resulting in the organization of a UNESCO mission in 1972. After the visit of Mr Wise and Mr Curiel as UNESCO consultants, two ICCROM specialists, Prof. Torraca and Prof. Mora, made a field trip in the same year.

With contributions from members of the Ministries of Culture and of Tourism, Prof. Cevat Erder, head of the Department of Restoration at the Middle East Technical University (METU), Prof. Kemal Balkan, Turkish delegate to the Council of Europe, and the two above-mentioned ICCROM specialists prepared a report on the conservation needs in the region. Two main projects – the first dealing with the interior surfaces of the rock-hewn churches and the other dealing with the structural problems – resulted from this cooperation. The former began in 1973 and the latter in 1982.

Conservation of the wall paintings in Göreme Valley can be considered as the first scientific activity in the region. The fieldwork continued successfully until 1990 thanks to cooperation between the Ministry of Culture and ICCROM. Conservation of Tokalı Church was completed in 1980, and of Karanlık Church in 1990. Still, such work can never be totally completed, as it naturally requires continuous maintenance, and so this collaboration should continue. It should be noted that the specialists of these missions also carried out urgent conservation interventions, such as in Kılıçlar, Saklı, El Nazar, Elmalı and St Barbara Churches. A traditional dwelling in Ürgüp was restored by the Ministry of Culture for use as a Research Centre.

In 1973, another important event occurred. The region encompassing Nevshehir, Avanos and Ürgüp was registered as a "Priority Region in Touristic Development" by Government Decree (№ 7/5811). Soganlı and Ihlara Valleys and the underground cities of Kaymaklı and Derinkuyu were also included.

Being World Architectural Heritage Year, 1975 was an important date in the history of the area, with two major activities. The first was the field survey by Mr Granier, a UNESCO specialist. His report focused on the potentials and the problems of the Göreme Valley, and created the basis of the Structural Conservation Project of Göreme, of which more later.

The second activity of 1975 was the preparation of the Conservation-Development Project of Ortahisar, as a contribution of Turkey toward the World Architectural Heritage Year. That project was prepared by the Department of Restoration, METU, and supported by the Ministry of Culture, for exhibition in Amsterdam. As a continuation, the project was adapted to provide a master plan for the settlement, through cooperation between the Ministry of Culture and the Bank of Provinces. As a consequence, the project has become a practical reality, yet there still is no implementation on site even today.

In 1976, legislative measures at the environmental level were established by the "Cappadocia General Conservation Plan." Historical and natural sites representing the regional characteristics of Cappadocia were registered by the High Council of Monuments and Historic Sites (A-69). This project aims to control environmental qualities, balancing natural and historical values and the man-made environment. As a result of this decree, construction activities anywhere in the region have been either totally restricted or limited to varying degrees according to their inherent cultural values. These objectives were also supported by the "Cappadocia Tourism Development Plan" prepared by the Ministry of Tourism.

Although the beginnings of research on the structural problems of Cappadocia can be seen to have started quite early, no practical results were achieved until 1979, when the United Nations Development Programme (UNDP), the Ministry of Tourism and Information and the Ministry of Culture had collaborated and Project UNDP/TUR/79/012 A/01/13, "Structural conservation project for Göreme," had been prepared. The project was signed by the Turkish Government in 1981 and registered as a National Project of Turkey by a Government Decree in November 1982 (№ 8/5305). This research project, originally expected to last for 2½ years, was extended until 1988 because of the complexity of the problems. It was operated by the Ministry of Tourism and Information until 1984 and by the Ministry of Culture from then on.

The UNDP budget for the project was US$ 178 000, covering international consultancies, supply of surveying equipment, and a fellowship programme. The total contribution-in-kind of the Turkish Government was the equivalent of LT 18 065 000.

The immediate objectives of the project were:

a) Development of a series of technically proven solutions to the structural problems of the rock structures of Göreme.

b) Consolidation of at least two major rock structures on a pilot basis by applying the techniques and solutions identified as most suitable.

c) Establishment of a point of reference, from both a financial and a technical point of view, for future work on the consolidation of the rock structures in the Cappadocia region.

d) Identification of suitable measures to maintain the sites and to prevent degradation caused by human factors while at the same time allowing a maximum number of tourists to visit the site.

e) Creation of a capacity, in terms of both trained manpower and organization, to apply the methods and techniques developed under the project systematically on the basis of a priority programme of action.

The activities of the project and their outputs were as follows:

1) Photogrammetric Documentation. Surveys were undertaken by experts of METU with the aim of documenting the existing situation – both architectural and natural – to provide a reliable basis for future restoration interventions. As a result of the surveys, the documentation of the Elmalı, St Barbara, El Nazar, Holy Virgin, Kılıçlar, Karanlık and Tokalı churches was completed in 1:50 and 1:20 scales.

2) Rock Sample Analyses. The aim of this research was to determine the types and the depths of deterioration of the volcanic tuffs in order to decide on methods of conservation. A four-stage methodology was to be used: (1) preliminary fieldwork; (2) detailed analyses; (3) evaluation; and (4) determination of appropriate conservation methods. The research was carried out by a group of experts from METU and the first three stages have been completed.

3) Meteorological and Topographical Surveys. Maps of the region have been prepared at 1:500 and 1:1000 scales. For the collection of relevant meteorological data, a meteorological station – comprising four rain gauges, a barothermo-hygrometer and a wind recorder – was installed in the area. The rain gauges were installed with the assistance of an international consultant and experts from the State Meteorological Office, and the other elements of the observatory were installed by the State Meteorological Office alone. Data collection is continuing. Two personnel from the Ministry of Culture received training in handling this station.

4) Hydrogeological Surveys. This research aimed to identify the water sources and drainage conditions of the rock formations in order to establish an effective drainage system. The survey was delayed until 1987.

5) Supply of Materials. Equipment and chemicals were purchased, except for photogrammetry film, which was later supplied by the Ministry of Culture.

6) Technical Assistance. A number of expert missions were fielded during the project in order to identify problems, evaluate possible solutions, and to apply methods finally selected. These took place as needed during the project.

- The first expert mission was in 1982, with the participation of Messrs Bowen, Verité and Lizzi and coordinated by ICCROM. The aim of this mission was to inspect the damage and to advise on conservation methods.
- In 1985, three missions took place. A UNDP hydrogeologist visited Göreme for the installation of the meteorological instruments. Secondly, ICCROM experts Messrs Lizzi, Rossi, Torraca and Malliet conducted some field experiments to test the applicability of mortar samples produced with local material. Thirdly, a Turkish team, in cooperation with the State Bureau for Hydrological Affairs and with Prof. Canike, geologist, from Konya Selçuk University, contributed to a field survey involving drilling and injection tests to provide consolidation data.
- The last mission was fielded in 1986, involving Messrs Rossi and Malliet. They evaluated the 1985 tests; installed crack-movement monitoring points in St Barbara, Elmalı, El Nazar and Holy Virgin churches; and installed surface-erosion monitoring points on the roof of Elmalı Church. Mr E. De Witte, Institut Royal du Patrimoine Artistique, Belgium, who had completed a one-year laboratory investigation on the rock structure of the region under sub-contract from ICCROM, visited the region in August 1987 and 1992. Several *in situ* tests with water repelling and consolidating chemicals were carried out to assess their effectiveness against erosion and water infiltration. An Italian chemical firm made a series of similar *in situ* tests with their own products in 1986.

However, due to the complexity of the problems, and although the research required by the project had been completed, technically proven solutions could not be concretely developed and implemented on a specific structure, with the exception of El Nazar. In conclusion, it can be stated that:

- Through the project activities, cooperation was established with other organizations: at national level with universities such as METU, the Istanbul Technical University, and government agencies, such as the State Bureau for Hydrogeological Affairs and the State Meteorological Office; and at international level with UNESCO and ICCROM experts and the chemical firms and laboratories consulted throughout the project. This collaboration should be revitalized.
- Priority should be given to the application of techniques and solutions for the consolidation and preservation of the churches that need the most urgent action to avoid further deterioration. This is the only way to achieve the broader objective of the application of measures against erosion and for consolidation on a wider scale in the region.

In 1983, another activity at international level was officially started: the UNESCO International Campaign to Safeguard the Historic Monuments and Sites of Istanbul and the Site of Göreme. This campaign has aimed to provide financial support for the structural conservation project for Göreme and the project for the preservation of historic monuments and sites of Istanbul.

The activities carried out under the action plan are (1) promotional activities; (2) providing funds based on national and international resources; and (3) activating other financial resources.

Promotional activities at the national level were realized between 1983-1985, and included the preparation and distribution of two brochures and two books on the projects of Istanbul and Göreme; the publication of 40 000 Göreme posters; and the preparation and sending to Japan of an exhibition on the two projects of the campaign. These activities were carried out by the Ministry of Culture. A commemorative series of stamps carrying the title of the campaign was issued.

Funds were also established at international and national levels. A UNESCO Trust Fund for the Campaign was set up in the USA to receive donations for the Istanbul and Göreme Projects. Parallel to this, a bridging account was established by the Yıldız Foundation (Emlak Kredi Bank) until the National Fund could be established.

A Round Table Meeting was held in Istanbul in June 1985 to introduce the projects and solicit contributions from major business entities in Turkey. Regrettably, donations did not reach the amounts expected. It has therefore become necessary to find new resources. Some support for the campaign came from income from exhibitions that were sent abroad, such as those in 1985, namely the Anatolian Civilizations Exhibition, the Turkish Pavilion of EXPO 85 in Japan, "Turkey: The Land of Civilizations" and the "Turkish-Islamic Exhibition" in the Federal Republic of Germany.

As can clearly be seen, though there have been several delays in the proposed schedule, both the Structural Conservation project of Göreme and the UNESCO Campaign to Safeguard Göreme and Istanbul have been continuously carried out with the contributions of the partners involved.

One very important action was the nomination of Göreme Valley to the World Heritage List. The nomination document was prepared by the Ministry of Culture with the contribution of Mr Hiroshi Daifuku as UNESCO consultant. This nomination was accepted in the 9th Meeting of the World Heritage Committee, in December 1985. The intrinsic qualities of the Göreme Valley – comprising both natural and cultural values within a historical context – totally fulfils the criteria of the World Heritage Convention. In this respect, the "outstanding universal value" of Göreme Valley has been recognized by the whole world.

The last project – to provide a sign system specifically designed for Göreme Valley – was carried out by the Department of Industrial Design at METU in 1990. The project has not yet been fully implemented.

Preparation of master plans for the settlements in Cappadocia are still continuing under the control and guidance of the Ministry of Culture.

In conclusion, one can say that, to protect the cultural values inherent in Göreme and recognized worldwide, there have been numerous research projects, planning activities and interventions, all oriented towards restoration and preservation over a long period of time. Such an accumulation of knowledge and effort should be revitalized in order to achieve concrete results in the very near future.

THE HISTORICAL AND ARCHAEOLOGICAL HERITAGE OF GÖREME

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ABSTRACT

The rock-hewn churches of Cappadocia are a unique record of the Early Middle Ages and the Byzantine tenth century, when Asia Minor was the Empire. There is no comparable group of churches from this time. In addition, Cappadocia has some highly significant Byzantine artefacts without equivalent elsewhere. Christian activities were a direct continuation of the pagan, with only two breaks known: during the Muslim invasions (eighth century and beginning of the ninth), and during the state of war (twelfth century) before the Seljuk renaissance. Archaeology and written material illuminate the region's history, showing that for scientific, artistic and ethical reasons we have an obligation to try to save all the Avanos-Çavushin-Maçan-Göreme area. However, damage has been occurring at such a rate that it could be asked whether or not it is almost too late.

The administrative area now known as Göreme includes two historical sites: Matiane (Maçan, Avcılar), a small town known since antiquity; and Korama (Göreme), a neighbouring valley initially inhabited and later the site of monastic establishments from the ninth-tenth to the eleventh centuries.

The two names appear in the *Passio Prior* of St Hiero, which probably dates from AD 515. Hiero lived in Matiane; he was a wine-grower who enlisted in the Roman army, and was martyred in Melitene, but his severed hand was sent to his mother and probably deposited as a relic in the Basilica of Çavushin.

However, the Christian establishments were successors to the pagan. Indeed, the Christian history of these sites is linked in ancient literature to the neighbouring town of Venasa (Avanos). From Strabo [*Geography*, 12, chapter 2, § 5], we know that the holy city was dedicated to the heavenly Zeus (*Zeus Ouraneos*). The high-priest of Venasa was the third most important person in the Kingdom of Cappadocia (after the king and the high priest of Comana). By the end of the fourth century the Christian

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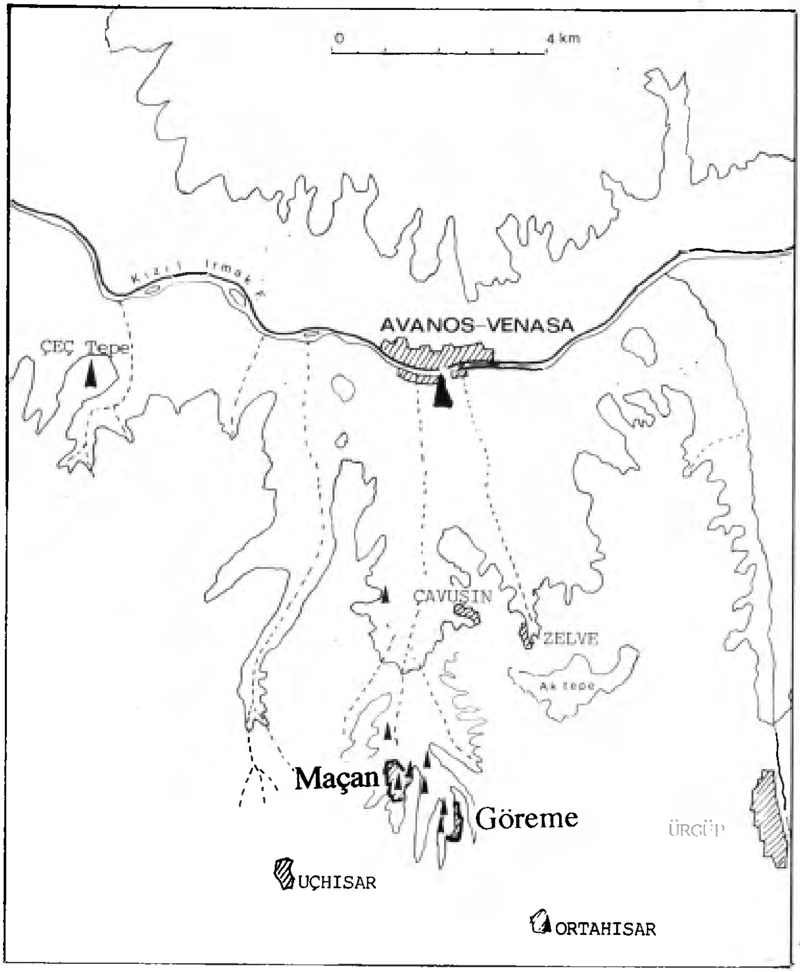

Figure 1. Map of the area of Avanos-Maçan (Avcılar) – Göreme. (The black triangles indicate ancient sites.)

city was flourishing, with numerous clergy and a martyrium being built (see the twentieth letter of Gregory of Nyssa, and letters 246-248 of Gregory of Nazianzos). Recently, a palaeo-Christian necropolis was discovered. It is likely that the religious character of the region in the Christian era has its origins in pagan pilgrimages [Thierry, 1981; Anon., 1987].

In the green valleys of Maçan, many rock-cut tomb chambers recall Greek and Roman times. Some even retain their vestibular columns. The most beautiful were no doubt those of the high priests of Venasa. The necropolis of Maçan extended throughout Göreme valley [Thierry, 1987:108-113, 128-136; 1984a; Anon., 1982].

Venasa was destroyed and the region devastated by the Persian invasions.

The first Christian settlements were dispersed, with villagers and monks alike grouping around the springs. In Maçan, across from three ancient tombs in Karshı

Bacak, one can see two important proto-Byzantine basilicas (one is Durmush Kilisesi, with an exceptional central ambo; the other, anonymous, is partially filled with sand and in danger of disintegration) [Thierry, 1984a], with a third, a funerary church of the seventh-eighth century, with paintings and inscriptions [Thierry, 1984b: 318-320]. Another ancient church was destroyed during the construction of a hotel below the three tombs. Göreme was then both countryside and a cemetery for Maçan. Early on, Christian monasteries gradually spread up from Venasa into the dales of Zelve, on the other side of the Kızıl Irmak.

Around the Basilica of Çavushin, which became a church of pilgrimage [Thierry, 1983: 59-109], many small hermitages were established, dotting the ravines of Aktepe. Here there are numerous chapels from the Early Middle Ages, of which two are particularly important: the Church of Joachim and Anna (which has the oldest Byzantine cycle of the childhood of Mary); and the Church of Niketas the Stylite, which is one of only five churches decorated in Eastern-Greek style and donated by a kleisourarch posted to the eastern Byzantine frontier [Thierry, 1993: 203-237, 255-281].

The frequent Muslim invasions – extending over nearly a century, from the eighth to the beginning of the ninth century – devastated the region. Following the Byzantine victories at the end of the ninth century and at the beginning of the tenth, the province once again became peaceful and prosperous. The second half of the ninth century saw also the end of the Iconoclasm period (727-843), although it seems that in Cappadocia, Iconoclasts and Iconodules had lived side by side. However, after 843 the churches were decorated with figurative paintings.

The re-population of the area was patchy: almost nil at Zelve, while Göreme began to develop as a religious centre, due to the revival of Maçan (which became a bishopric at the beginning of the eleventh century). At Göreme the Christian cemetery re-occupied the ancient necropolis.

From the end of the ninth century to the beginning of the tenth, small monasteries grew in number. In the valleys of Aktepe, ancient churches were renovated: the apse of Güllü dere Nº 3 was painted; the two chapels of Nº 4 were repainted (beautiful paintings from the workshop of the Old Tokalı and dated 913-920); and the pigeon house of Kızıl Çukur, Haçlıkilise, excavated in the Iconoclastic period, was beautifully painted in the early tenth century [Thierry, 1983: 117-181; 1993: 245-254].

The monastic settlements in Göreme were spreading up the valley from the end of the ninth to the end of the eleventh centuries. Numerous little churches can be seen in the low valley [Jerphanion, 1925: 95-294], likewise a unique painted tomb [Thierry, 1984a: 666-678]. The region was under the authority of the bishoprics of Matiane (Maçan) and Hagios Prokopios (Ürgüp).

Göreme's heyday dates from the time of the Phokas, the most powerful aristocratic family of Cappadocia, whose fortunes lasted from the middle of the ninth to the beginning of the eleventh centuries. Their capital was Kaisareia (Kayseri) [Kaplan, 1981]. The founders of the New Church of Tokalı [Jerphanion, 1942: 297-376] have recently been identified as Nikephoros Phokas (before he became emperor in 963); an unknown nephew, Leon; and his brother Constantine, who died in captivity after 953.

Thus the paintings can be dated to about 950 [Thierry, 1989a:217-233]. This explains the beautiful pictures, the high-quality iconographical programmes and the costly materials used, such as lapis-lazuli and gold.

The New Tokalı is an excellent example of Byzantine Macedonian renaissance artistic achievement. It provides evidence of the power and richness of the Anatolian aristocracy. Likewise, we know that the Phokas treated as an equal the Georgian king David Curopalate, ruler of the Tao (east of Erzurum). And we have only the royal Georgian creations to compare with the New Tokalı murals, primarily the paintings in the cupola of Ishan, from about two or three decades later [Thierry, 1977b: Ch.5; 1989a: 230-231]. Hence we can hypothesize that aristocratic families of Asia Minor were able to support great workshops of painters.

The Phokas' patronage in Göreme explains the foundation in neighbouring Çavushin of a church dedicated to the commemoration of the victories of Nikephoros Phokas, his brother Leon, his father Bardas, and two chiefs of the Army of Asia [Jerphanion, 1942: 511-550; Rodley, 1983; Thierry, 1983: 43-57]. Here one can see the only known example extant of a Byzantine imperial triumph (albeit in modest shape, since the paintings are rather mediocre and the donors feudal lords of modest means). We see the Empress Theophano, the Prince Basil and the three Phokas looking at two horsemen marching from the left as if on parade (John Tzimiskes, later emperor, 969-976, and Melias). We can therefore speak of the "Church of Nikephoros Phokas," rather than the "Pigeon House Church of Çavushin."

In the eleventh century – an era of general prosperity – the monasteries multiplied and grew larger. Most new churches were painted, although the quality of the art was uneven – some of the paintings being provincial, others comparable to those of the best Byzantine workshops.

As for the three famous columned churches (Çarıklı Kilise, Elmalı Kilise and Karanlık Kilise) situated at the end of the Göreme valley, it is now generally agreed that Jerphanion's dates are correct, i.e., around the middle of the eleventh century [Jerphanion, 1942: 377-473; Rodley, 1985: 95-103; Thierry, 1983: 43-57]. Their paintings are good examples of aristocratic Byzantine works, and the portraits of the donors tell us their social ranks: a priest, landlords of the local aristocracy, etc. In the narthex of Karanlik Kilise one notes the most important of them: John entalmatikos, the title being probably that of an emissary of the Patriarch of Constantinople. He is dressed as a high dignitary of the court of Emperor Nikephoros Botaniate and illustrates the importance of the Cappadocian monasteries at that time.

Some provincial churches are interesting owing to their ioconographical programmes such as Saklı Kilise, the Church of Meryemana and the Yusuf Koç Kilisesi in Maçan [Restle, 1967: 279-310, Figures 21-44; Thierry, 1977b: Ch. 9]; the first two because of their Christological cycles and the third because of its many images of saints. In all, we find donors' portraits of varied kinds. Likewise in some modest Göreme chapels, where the icons with ancient graffiti give evidence of the people's devotion.

It would appear that the religious life of the region was waning by the end of the eleventh century, as no foundation has been found from the thirteenth century, which was the era of renaissance of the now Seljuk Asia Minor. The rural and monastic centre of Maçan-Göreme-Çavushin no doubt suffered from the decline of the bishopric of Hagios Prokopios. In contrast, elsewhere new centres were growing up, such as Damsa, Soganlı and Erdemli.

* *

The monuments of Göreme-Maçan-Çavushin are very important to the understanding of the Christianization of a pagan holy city's region, the people's changes during the Middle Ages, rural and monastic cohabitation, and the evolution of image worship before and after Iconoclasm. In the tenth century churches, as in the earlier, one can see numerous early Byzantine images (cycle of Mary's childhood, prophetic visions, Virgin of Tenderness, Dormition of Mary, Evangelists and Last Judgement, Eustathios' vision, and so on).

Moreover, the history of the Byzantine Empire is brilliantly illustrated by the Phokas' patronage in Göreme and, in Çavushin, the commemoration of their victories against the Arabs (964 and 965).

Consequently we must save this historical and archaeological heritage, not only the Göreme circle but also the churches all around in the area of Maçan-Çavushin towards Avanos.

* *

However, sites and monuments are in danger of disintegration, with human causes patently reinforcing the natural causes. Thus the last column and the porch of the Çavushin Basilica have already fallen down; the vault of the Nikephoros Phokas church has a transverse crack which widens every year; the church of Meryemana is breaking apart, as is the high gallery of the big proto-Byzantine monastery of Özkonak; and so on – an inventory needs to be taken.

Painting damage has increased over the last ten years. In the guarded but heavily visited churches the paintings are attacked by the water vapour and carbon dioxide breathed out by the crowds of visitors (up to 5 000 daily), and direct abrasion occurs where no chain barriers exist (or are ignored).

In the isolated and unguarded churches, damage results from numerous causes. One can see visitors' graffiti, particularly in Ihlara valley, and near Göreme in the very old Church of Niketas (dating from 991). But far worse have been the intentional destructions, particularly in the area of Çavushin-Maçan-Göreme, i.e., within the "Historical Park." Several times the very old paintings of the Çavushin Basilica have been scratched off: first in 1983-84, then in 1989-90, and finally the remaining paintings have been washed over with green. In the neighbouring valley of Zindanönü, faces were scratched off in 1987 or 1988. In Kılıçlar Kilise, faces and names were destroyed which had survived intact to 1988, namely James and Philip above the door. In Saklı Kilise, the Crucifixion has been smeared with black.

Vandalism has also been noted in Babayan and Shahinefendi churches, and the very interesting paintings of Mazıköy were completely destroyed three years after their discovery in 1986 [Jolivet-Levy, 1991: 177-178] – and not all sites have been checked!

Its seems that this kind of damage is connected with a re-awakening to radical Islam in the countryside.

* *

As for environment, the inventory shows a disaster. Reading the "Master Plan for the Historical National Park," formulated more than 20 years ago [Anon., 1971], we are obliged to conclude that nothing was done for the safeguard of the erstwhile marvellous village of Maçan-Avcılar. Campsites, restaurants, guesthouses and advertising hoardings intrude everywhere, and are proliferating along the roads. There has been an anarchic multiplication of hotels located in the landscape at the expense of gardens and cones. For instance, in Maçan, in the old ruined centre, there are now new, poorly-built, boarding houses; in front of Karshi Bacak, there is a new hotel, well built but too wide and high; and in El Nazar valley a very large settlement has been established. The worst is above Ortahisar – an enormous, eight-storeyed building; in comparison, the *kale* of the village has been made ridiculous.

All these settlements unbalance a precarious village organization, with particular pressure on water supplies.

Damage can be increasingly seen in the countryside. Road widening and opening, digging for car-parks and viewing points are more and more numerous. Opening of footpaths across fields and orchards adds to the destruction of the environment. Numerous conflicts exist between peasants, villagers and tourism workers. It does not help that some tourists are not strictly correct: in short, mass tourism is not appropriate to Cappadocian sites.

* *

What kind of defence should be adopted? Major decisions need to be made by the Turkish authorities, in close consultation with the relevant international organizations, on both technical and territorial matters. At the same time, one can do nothing without the cooperation of the local population. Civil and religious authorities, villagers, tourism workers and the business community will have to work together towards a consensus for a sustainable development of the area that respects everybody's interests in so far as that is possible and compatible with preservation of the unique cultural heritage that is the Göreme area.

Nevertheless, to find effective methods of curbing the increasing deterioration is a very complex problem.

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THE ART-HISTORICAL SIGNIFICANCE OF ROCK-CUT CHURCHES IN GÖREME

S. Yıldız ÖTÜKEN

1. INTRODUCTION

When the Frenchman, Lucas, published his travel diary in 1714, the western world's attention was drawn to the hitherto unknown region of Cappadocia, in Turkey. As a result of the interest aroused, travellers and researchers visited the region during the nineteenth century, including Hamilton, Ainsworth and Texier [1]. In the same century, Lebides, both director and principal lecturer of the Greek School in Kaiseri, published a book mentioning the region's churches and monasteries for the first time [2]. During the early twentieth century, the first art-historical appreciations of the monuments were expounded by Rott and Jerphanion [3]. In 1925, the most significant churches in Göreme – Elmalı and Tokalı – had been included in a general description of Byzantine Arts [4].

The historical development and topography of Cappadocia during the Middle Ages have not yet been satisfactorily studied. Arab and Byzantine sources from the seventh to the eleventh centuries mainly deal with political history, which is of little use in evaluating the social and economic situation of the Christian population [5]. The decline of archives and libraries in the Near East meant fewer sources regarding ecclesiastic foundations in the region.

Very few archaeological aspects of Cappadocia in the Middle Ages have yet been investigated, with no scientific excavations having been made of mediaeval settlements in the region. This is very regrettable, considering that Cappadocia was one of the Byzantine Empire's most important religious centres. So far, 780 churches or monasteries have been identified, but only a quarter of the monuments are conserved.

To ensure the preservation of these monuments, immediate action to protect them must be taken [6]. Because of its frescoes and inscriptions, as well as for its landscape, Göreme can be considered a special case amongst the settlements in Cappadocia. Thirty-seven buildings were mentioned in a work by Jerphanion (1925-1942), and more recent publications bring the total to 57 [7].

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The aim of this report is to present a short overview of the importance of the rock-cut fabric within the history of architecture and painting.

2. ARCHITECTURAL CHARACTERISTICS

2.1 Construction types

Göreme's rock-cut churches show nine variations on the five basic Byzantine ground plans. Single-naved churches with a transverse (13 examples) or longitudinal (11 examples) naos, and cross-domed churches (8 examples) are the most common. Centralized buildings of circular, octagonal, tetragonal or triconchos construction are unknown [8]. A rectangular, long-shaped room with an apse at one end and the entrance at the opposite end is the most elementary church form. The naos may be longitudinally (Type 1a, e.g., church Nº 9) or transversely rectangular (Type 1b, e.g., the New Tokalı). The double-naved church with two apses either divided (Type 2a) or not (Type 2b) by a row of arcades, represents the second church type. Both variants are found in at least one instance amongst Göreme's churches (St Eustachios and church Nº 35a in the Necropolis). The third group are the three-naved basilicas (Type 3), such as the church of the Aynalı monastery. There are two variations to be seen among the cross-in-square shaped churches with free cross arms: in the first case, cross-arms spread from a central square to each side (Type 4a), such as the church of St Katherina; in the second case, the apse integrates without interconnection of the eastern arm into the central square, as for example the El Nazar church. Two forms of cross-domed construction constitute the fifth group: the Kılıçlar church is a four-pillar-support building (Type 5a) and St Barbara is a two-pillar-support building (Type 5b).

2.2 Origin of construction types

Despite the loss of the masonry churches, Göreme's conserved rock-hewn constructions provide evidence of the various construction types. No single-naved masonry church of a transversely rectangular ground plan has survived in Cappadocia, but 17 rock-hewn churches of this type are known. Thirteen of them are located in Göreme, with the others in Kepez, Açıksaray and Elevra [9].

The so-called transept-construction has its origin in northern Mesopotamia. Tur Abdin and Cappadocia are the only regions in Asia minor where this construction type is found. There is no example in the capital[1] [10].

The view adopted by scientists is that the construction type was introduced into Asia Minor by master masons coming from Syria [11]. The earliest examples of double-naved ground plans were in Syria during the early fifth century. It was quite common in Tur Abdin, while it had appeared in Isauria by the end of the fifth century (Alhan Monastery Baptisterium) and immediately afterwards in Cappadocia [12].

1 Istanbul [Constantinople] being the capital during that period.

The Nea church (880) in the capital provides the earliest example of a cross-domed construction. Similar examples in Asia Minor are the churches of Side and Tirilye. Göreme's Kılıçlar (900) is the first rock-hewn example. Vault systems that are not conserved amongst the masonry churches can be observed in the rock constructions. The five-domed Nea church is very similar to the Kızlar and Elmalı churches in Göreme.

The free modelling of the cross-arms and corner room vaults should be noted. These arms, which are usually covered by barrel or cross-vaults, are vaulted by domes in the cases of the Elmalı, Kızlar and Çarıklı churches. The double-pillar construction found in northern Syria since early Christian times is rarely found in Asia Minor. The only known examples are two masonry churches in Lykaonia: the Eustathios in Meran, and the Amphilochios in Konya. Three rock-hewn churches of this type have been conserved: Barbara and Çarıklı in Göreme, and the Cambazlı in Ortahisar.

2.3 Vault systems

The vaulting of rock-hewn churches combines barrel, dome, cross-vault and flat-roof forms. Çarıklı's eastern cross-arm and all cross-arms of the Kızlar and Elmalı churches are topped with domes. In the case of Elmalı, even the corner rooms are domed, so that a nine-domed interior is created. Flat roofs may top the corner rooms as well as single-naved churches of this type, as, for instance, Saklı and church Nº 3.

Göreme offers solutions that would be impossible to achieve in masonry: for instance a short dome integrated into a flat-roofed or barrel vault (e.g., Kılıçlar and Nº 27, as well as Kızlar). Two examples of a vaulted nave and flat-roofed aisles can be observed in Old Tokalı and Aynalı.

The connecting elements were copied from brick architecture, such as the dome on pendentives (Kızlar; El Nazar; Nº 5a and 6a), or on modelled triangles (Old Tokalı; Nº 25). These triangles are also used to connect flat roof or barrel-vaults (Elmalı; Karanlık; Barbara; Kızlar), and, in the case of church Nº 5a, the dome is placed on a drum.

2.4 Sculpted architectural elements

Rock-hewn churches show imitations of static elements of architecture: New Tokalı's transverse barrel vault is "supported" by two belt arches, similar to the Aynalı. The dome's arches rest on wall pilasters or dosserets, as in El Nazar and Karanlık. The columns of the Kızlar, Karanlık and Kılıçlar churches show dosseret capitals with an abacus, and the Kılıçlar Kushluk has a cubiform capital. Some of Göreme's churches have rich decorations on their exteriors and interiors. New Tokalı's interior walls are broken up by pilasters, arched niches and corniches, blind arches and carved crosses. Short columns and pilaster arcades decorate the interior surfaces of domes (Nº 15a and 35b; Katherina) or those of the drum (Nº 5a). Elsewhere, neatly carved consoles decorate the wall corners (Katherina) or the dome (Kılıçlar).

Arcades, pilasters and corniches form the exterior walls of the monastic foundations of Karanlık, Çarıklı and Aynalı. There are also cross reliefs above entrances, as seen in the Katherina church.

2.5 Liturgical elements

Rock-hewn churches have conserved liturgical elements, such as altars, ikonostases, and synthroni, which were destroyed in their masonry counterparts. Towards the naos, the apse is usually delimited by two massive slabs. Göreme's cross-shaped churches, such as Barbara, Katherina, Çarıklı, Nº 25 and 27, show the most elaborate examples of those pierced, high ikonostases. Kızlar contains a completely conserved ikonostasis, decorated with cross reliefs and polychromy [16]. In New and Old Tokalı, as well as Kılıçlar, the sanctuary is separated by a high row of arcades. In most of the churches, rock altars and a seat or rock-hewn benches along the walls of the naos are conserved. Only Karanlık and New Tokalı contain single seats with armrests for high-ranking clergymen [17]. The passages through the apses of Karanlık and Nº 25, the added northern apse of El Nazar, as well as Old Tokalı's font, are the result of liturgical needs.

2.6. Graveyards

The rock-cut churches provide evidence of the burial tradition during the Byzantine period [18]. Constructions like Nº 35 within the necropolis and Tokalı contain grave-churches. The Tokalı conserves floor and arcosolium tombs and a separate grave-chamber. One nave of the Eustathios church was used as a grave-chamber, as in most of Cappadocia's double-naved churches. Old Tokalı, Karanlık, Nº 18 and 27 all contain separate grave chambers. Traditionally, there are no tombs within the naos, but often the narthex is used for grave laying, as in the case of Daniel, Katherina, Old Tokalı, Nº 9 and 27.

2.7. Monasteries

The four monastic foundations of Göreme – Aynalı, Çarıklı, Karanlık and the monastery situated 50 m from Kılıçlar – group their common rooms around an open courtyard [19]. Very little is yet published about the Kızlar monastic foundation. Various rooms and chambers are situated within a rock cone. The main church of Archangel's monastery (mentioned in an inscription) was the Tokalı. None of the monastic buildings are conserved [21].

An extensive overview of Cappadocia's rock-cut monasteries is provided by Rodley (1985). However, many questions are still to be answered. There is still insufficient knowledge of the social and religious position of the monasteries within the region. The number and mission (duty) of the clergymen, as well as their relationship with architecture, is still unknown. The variety in number and form of the monastic constructions are clearly illustrated by the excellent ground-plans in Rodley's book, but we know almost nothing about their function. The author only distinguishes churches, "trapezes," entrance halls and grave-chambers.

3. MURAL PAINTINGS

3.1 Inscriptions

No comprehensive survey of inscriptions in Göreme and Cappadocia has yet been published. Göreme offers two dated inscriptions: one within the Eustathios, the other in the Kızlar church. Tokalı contains two inscriptions, naming the donor and the painter of the church. A further 23 representations of donors are conserved in Göreme, 15 of which bear inscriptions [21]. The inscriptions rarely contain information about the social status of the donor. Inscriptions located within the apse and the narthex of Karanlık church merely state that the donors were Nikephoros, a presbyter, and John, an entalmakios [22].

The rich clothes of the donors give evidence of their aristocratic origin, such as John in the Karanlık, and Theognostos, represented in the Çarıklı church. Images of female donors, such as Eudokia, Anna and Eronikea (within Daniel, Katherina, Kılıçlar Kushluk) prove the importance of women amongst the donors [23].

The existence of all these significant architectural and decorative elements underscores the general importance of Göreme as a repository of cultural heritage, and so the historical value of Göreme's inscriptions should be emphasized and attention drawn to the need to support the Göreme project for urgent protective measures [24].

3.2 Cycles and iconographic programmes

Three of Göreme's churches are of unique significance because of the preservation of the numerous frescos. New Tokalı has 49 scenes, Old Tokalı 34, and Kılıçlar 33. The only comparable church of Cappadocia would be the Hac Kilise in Mavrucan, where 33 scenes are preserved [25].

Besides Christological series, scenes from the Old Testament are also represented. Elmalı has the Philoxenie and the Three young men within the fire, as well as scenes from the Virgin Mary's life. The earliest example of a Virgin Mary series in Cappadocia is located in Kızılçukur, in the Joachim and Anne church [26]. Single Virgin Mary scenes are preserved in Kepez (Sarıca church), Kılıçlar and church № 9 in Göreme. New Tokalı's Pentecost scene has no equivalent elsewhere in Byzantine monumental painting [27].

The iconographic programme of Göreme's churches contains hagiological scenes. Eleven scenes from St Basil's life can be seen in New Tokalı's naos. Although the cycle's conservation status is poor, with only five scenes preserved, it is important as the representation is unique in the Cappadocia region. Only two other scenes of Basil's life are conserved, namely in Ortahisar's cave-church, named Balkandere [28]. Scenes from St George's life are preserved in churches № 9 and 16 of Göreme. The only analogous depictions were found in the Karagedik church in Ihlara valley [29].

The dating of the frescoes requires, beside stylistic and iconographic analyses, a close study of their stylized iconographic programmes. The numerous cycles preserved in the various Göreme rock-hewn churches offer an ideal subject for research [30].

The sequential arrangement of scenes within the church (the iconographic programme), the choice of scenes, their biblical quotations and the emphasizing of single scenes, all these may provide evidence about their date of origin. New Tokalı's Crucifixion scene, complemented by four Passion scenes, decorates the church's main apse. This singular choice of location finds its only equivalent in the Pantokrator church in Istanbul. Comparing their similar characteristics, the iconographic programme of New Tokalı may be more akin to the twelfth century [31].

3.3 Iconography, style and technique

Göreme's frescoes are a rich resource regarding Christian iconography [32]. Some of the scenes noted above have no equivalent elsewhere, such as the Pentecost scene. Various scenes from the Christological cycles deserve special note. Thus some scenes, such as "Christ before Hanna and Caiphos" (Kılıçlar), "The calling of Matthew" or "Christ and the poor widow" (New Tokalı) are, within Cappadocia, only found in Göreme. The Pentecost scene and "Magi observe the star" are unique representations in Byzantine monumental painting, and found only in Göreme (New Tokalı) [33].

Of specific iconographic types of Christ and Virgin Mary representations, Göreme offers both unique and the most numerous examples. This is the case for "Christ in Mandorla" (Saklı, Katherina, Karanlık) and "Virgin Mary the Merciful [Eleusa]" (New Tokalı, Karanlık, Çarıklı and Tahtalı; Karabash in Soganlı) [34].

Rarely represented saints are found in Göreme: St Hieron of Matiana (Tokalı, Saklı, Kılıçlar); St Nestor, Simeon Stylites (Tokalı, Saklı); St Peter of Alexandria (Tokalı); and the martyrdom of Eustathios, Agapios and Theophistos (Tokalı). Church № 3 preserves single representations of 40 martyrs from Sebaste. Twenty-nine martyrs are depicted in New Tokalı [35].

Göreme's paintings date from between the ninth and thirteenth centuries. They therefore offer rich opportunities for stylistic research [36]. So far, research has been confined to trying to group the primary stylistic characteristics and to schedule those by style definitions. The "Yılanlı Group" might be useful as an example, where technical and stylistic analogies include the paintings in the following churches, dated between the second half of the ninth century and the first half of the tenth: Yılanlı, Barbara, Katherina, Daniel, № 11a, 18 and 28 [37].

Göreme's frescoes provide evidence of an iconographic and stylistic proximity to the capital, as well as to the surrounding regions of the Byzantine empire. Comparing the frescoes of El Nazar, Karanlık, Kılıçlar, Old Tokalı and New Tokalı, the art of the capital has clearly had an influence on Göreme [38]. Other publications indicate influences from Syria, Armenia and Georgia [39].

Little attention has been paid to the technical characteristics of the wall paintings, as almost no basic research has been published on that aspect for Göreme. The first indicative reports were published by Restle [40], and during the restoration works of the Tokalı frescoes, technical observations were made and published by Epstein [41]. All steps of the Karanlık Kilise restoration are summarized in Ozil's report [42].

4. STATE OF RESEARCH

Our bibliographic reference collection covering Christian monuments in Cappadocia includes 272 publications dated between 1900 and 1993 [43], of which 69 concern monuments of Göreme. Briefly, there are 28 publications concerning one or more monuments of Göreme, of which four are books and 24 are articles [44]. Three of the books are monographs on a single rock-hewn church: Cave on Kılıçlar; Epstein on Old and New Tokalı; and Wiemer-Enis on New Tokalı. All of them were originally dissertations and contain rather superficial descriptions of the wall paintings. The fourth book, by Ipshiroglu and Eyüboglu, is largely an illustrated general overview of Saklı Kilise.

Of the 24 articles, 15 concern Tokalı and the remaining 9 cover churches Nº 10a, 15a, Saklı, Barbara, Çarıklı Refectory and Karanlık [45]. Excluding architectural aspects, the authors' main interest was the wall paintings, analysed according to stylistic and iconographic criteria. Other publications on Göreme cover Tokalı (2 books and 15 essays); Saklı (a book and an essay); Kılıçlar (a book); Karanlık (5 essays); and Nº 10a, 15a, Barbara, and Çarıklı (one essay each).

Important edifices such as Elmalı, Çarıklı, Kavanlık and Kılıçlar Kushluk have been generally neglected because interest has focused on churches containing rich fresco scenes.

Despite numerous relevant publications, the dating of Göreme's monuments remains largely uncertain. Jerphanion, followed by several experts including Epstein, dated the New Tokalı church within the tenth century. The first to criticize this dating was Wiegand; recent, convincing studies by Restle and by Wiemer-Enis date the construction to between the twelfth and thirteenth centuries [46].

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LATEST NEWS FROM THE LAND OF FAIRY CHIMNEYS

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ABSTRACT

Cappadocia has been on the 'agenda for conservation' of the national authorities for several decades. The first intervention or attempt in this direction worth mentioning is the series of campaigns organized by ICCROM and the Turkish side to save the wall paintings in some of the major churches in Göreme. The second component of these campaigns, namely 'structural conservation' of the rock formations housing the churches, has not received proper attention from interested parties since 1973. In the meantime, the efforts of the local authorities concentrated on improvement of the sites, introduction of properly designed and managed visitor facilities, and development of temporary emergency measures to extend the future existence of the endangered monuments, with all these activities implemented within the guidelines set by the overall management and land use plan. This paper will describe briefly some of these less-known projects, which either have been executed or are in the planning stage.

Keywords

Land use plan; conservation town plans; site development projects; endangered monuments; structural conservation.

LAND USE PLAN

Studies for revision and updating of the existing land use and conservation plan of 1981 are almost complete. In a briefing to be held on Monday, 13th of September [1993], studies will be presented to the representatives of the Ministries of Tourism, of Forestry and of Reconstruction and Resettlement.

The Safeguard of the Rock-Hewn Churches of the Göreme Valley. Proceedings of an International Seminar. Ürgüp, Cappadocia, Turkey, 5-10 September 1993.

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Major planning decisions are proposed by the plan, namely:

1. Natural conservation sites are to be protected as they were declared in 1976. There will be minor adjustments made in areas bordering towns.
2. Spatial developments of towns located in the natural conservation sites – such as Göreme, Ortahisar, Cavushin, Ürgüp and Mustafapasha – will be frozen. In other words, the Ministry of Culture is proposing to the other ministries that there be an agreement to confine the physical growth of these towns to recently established zones.
3. Potential developers of new hotels will be warned of excess room capacity by the government agency responsible. Furthermore, it is also suggested that local authorities should be advised to review land use decisions for areas that have been reserved for tourism developments in the town plans.

The executive agency for the plan, once it is fully approved by both the Kayseri Council for the Protection of Cultural and Natural Entities and the High Council for the Protection of Cultural and Natural Entities, will be the Ministry of Reconstruction and Resettlement. The requisite studies will be finalized in that ministry with the assistance of the Ministry of Culture.

It is expected that the plan will receive final approval before the end of the year [1993].

While planning studies were being carried out, other projects of various scales and extents, all in harmony with the spirit of 'the plan,' were also undertaken.

CONSERVATION TOWN PLANS

Design of 'conservation town plans' for the urban sites within the historic sections of Göreme and Mustafapasa were commissioned in 1992, and both are due for completion soon. These plans will provide zoning criteria and the rules and guidelines to be used in the restoration and refurbishment of listed and unlisted buildings located in the historic zones. Similar planning studies for the towns of Ürgüp and Ortahisar are programmed for 1994.

All the four towns mentioned above are located fully or partially within the natural conservation sites.

SITE DEVELOPMENT PROJECTS

These projects are essentially aimed at improving the existing site facilities or introducing new visitor facilities so as to achieve better management of the sites. It is also the intention to rearrange or remove the tourist-oriented commercial activities that flourish at the attraction points.

Kaymaklı and Derinkuyu

Two architectural projects for site developments of this nature have been completed for Kaymaklı and Derinkuyu towns, where two of the more popular underground cities are located. Upper layers of these and other underground cities are still used by the villagers, who have their dwellings above the caves or cavities. This presents hygiene problems, and physical harm on occasions when sewerage piping fails. When the projects are finalized the underground cities will be protected from the adverse effects of both the settlements and vehicular traffic above, and better site arrangement and visitor facilities will enhance the immediate environment.

In Derinkuyu, acquisition of the private property located above the subterranean town has been completed.

Göreme Museum Site Development Project

With the project scheme, two changes will be brought to the existing layout. In one of the changes, closure to vehicular traffic is foreseen of the road passing through the site, and in the second one, parking areas will be relocated further away from the main entrance. The main entrance has already been moved to its new location. Groundworks and some masonry blockwork is finished. When the intended road and pavement finishes are in place, and with the help of landscaping, the not-so-pleasant appearance of the parking lot should improve. Closure of the road to traffic is expected to become effective before the next tourist season. This move will require some changes in tourist routes, but fortunately alternative routes exist and so there will be no need to cut new roads through the conservation sites. Landscaping to reduce erosion, perimeter security lighting, pavements and other townscape elements will be used throughout the museum grounds.

Zelve and Pasabagı

Zelve is the site of the rock-cut village which was inhabited until as recently as the 1950s, when people were moved to a nearby location because of increasing danger of collapsing rock formations. Since the late 1960s it has become a site frequented by visitors, wishing to see traces and remains spanning a millennium. Existing site management and visitor facilities have become quite inadequate. There is a study to bring a new arrangement to the site by upgrading or relocating some of the present visitor facilities. The scope and extent of commercial activities will also be re-assessed.

Pasabagı at present is on the route to Zelve from Göreme. It attracts visitors either by the sheer beauty and impressive number of chimneys or by the absence of admission fees, or both. There is no site management and no proper visitor facilities, and the site is run by peasants turned entrepreneurs, who used before to tend the vineyards and orchards. With the intended development, through traffic will be stopped by blocking the road and removing it physically from existence. Thus the site will display a layout more in harmony with the cultural landscape. The site will then become a destination point with proper site management and visitor facilities. Access to Zelve will be re-routed through Avanos, where a busy road already exists.

Acquisition of private property in both Zelve and Pasabagı has been completed. Total cost was close to half-a-million US dollars, and was fully met through collected admission fees.

Interventions on monuments

The monuments in danger due to failures of the rock structures housing them have come to the attention of international missions visiting the area over the last 30 years. Along with a few others, El Nazar, Elmalı and Meryemana (Virgin Mary) have been listed as monuments requiring more immediate attention than the others.

El Nazar is located midway between Göreme town and the museum, and 15 minutes walk off the road. The church is in a badly damaged rock cone, and the structure was vulnerable to destructive effects of both nature and visitors.

The main design concept was to provide a temporary enclosure to keep rain and snow away, and to provide work platforms and easy access to the outer surface of the rock. This would keep the cone intact until it could be treated and made structurally sound so as to withstand external forces. It was decided that the structure to provide the enclosure should be light, demountable and re-usable. It was also found necessary that all parts of the outer surface of the rock should be accessible from the work platforms and the employed structure should at no point touch the weak cone but leave it freestanding. Rapid and easy erection were considerations that affected choice and design much more than aesthetics.

In the end, tubular steel piping was used for the scaffolding, with steel roof trusses. The outer sides measure 14 by 15 metres and rise 17 metres from the lowest ground level. On the roof and part of the side walls, aluminium cladding was used. The rest of the sides are closed by wire fencing. Entrance to the enclosure is controlled through a locked door.

The total project cost was US$ 90 000, and this was fully met from admission fees collected on the six sites in the region.

Elmalı and St Barbara

A similar situation to El Nazar exists for Elmalı and St Barbara in the Göreme museum grounds. Here aesthetics as well as severe surface irregularities in the terrain required a totally different solution. Although the conceptual approach of protecting the rock from the direct effects of rain and snow is maintained, the design requirements did not include the need to provide means of access for consolidation works. The project will be implemented in three stages. In the initial stage, a tent-like structure suspended from a steel pole will be erected to cover both churches. In the second stage, a retaining wall will be constructed to counter the movement of the blocks on the valley side. Structural conservation of the rock formations should then be able to proceed.

The expected cost of the first two phases of the project is US$ 100 000 to US$ 125 000, depending on the outcome of the initial engineering geology surveys.

HISTORICAL BACKGROUND OF TOURISTIC DEVELOPMENT IN THE GÖREME AREA WITH RESPECT TO ENVIRONMENTAL PROTECTION

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ABSTRACT

The touristic development of Cappadocia, and in particular the Göreme area, has followed the spread of knowledge of this region throughout the western world, which occurred mainly during the 1960s and 1970s. After outlining the most significant stages of this spread of knowledge, a review is made of those projects which aimed, on the one hand, to develop tourism and, on the other, to conserve the historical and monumental heritage, consisting of rock settlements and mural paintings in the rock-hewn churches.

The development of tourism in recent decades has, however, increased to such an extent that the very conservation of this irreplaceable heritage is in serious jeopardy.

Based on the 1966 UNESCO mission report, criteria are specified for dealing more decisively with the complex series of problems involved in environmental and monumental conservation and determining compatible limits of touristic development.

Keywords

Touristic development; conservation; environmental protection.

1. INTRODUCTION

"*Les chapelles et les oratoires d'Urgub se comptent par centaines … Esperons que un jour viendrà oû ces monuments seront l'objet d'une étude plus speciale e seront ainsi sauvé de la destruction.*" (Texier, 1859)

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When in 1966 Piero Sanpaolesi invited the author to take part in the team appointed by UNESCO to study the problem of conserving Turkey's monumental heritage in anticipation of the general plan for the development of tourism, the region of Cappadocia was still practically unknown to the public as a whole, although initiatives had been underway for some years to encourage the forerunners of what were subsequently to become the present-day hosts of tourists to visit the area.

Even from a scientific point of view, knowledge of this region was scanty.

If one excludes the pioneer researchers of the last century and early years of the present century, the only study made of the region was the monumental and fundamental work of Jerphanion, published between 1925 and 1942, which was joined later by the significant work of the Thierrys, published in 1963.

These were, however, specialized studies, intended for a small circle of scholars and researchers and therefore largely ignored by the history of art manuals.

It must, however, be said that the incomparable *Guides Bleus* promptly recorded the state of research in their volume on Turkey, and clear details of the *Nouvelles églises rupestres,* only recently discovered by the Thierrys, appeared in their 1965 edition.

The relative silence surrounding this region and its art treasures can be accounted for not only on the basis of "exclusivism on the part of the scholars" (Sanpaolesi *et al.*, 1966), but also because of the country's complex political situation, which particularly during the period between the two World Wars and up to the 1950s made access difficult for the few interested scholars

2. SPREAD OF KNOWLEDGE THROUGH MASS MEDIA AND THE DEVELOPMENT OF TOURISM

The first richly-illustrated article on Cappadocia to appear in a widely-circulated magazine of renown was written by Sitlington Sterret and published in the April 1919 edition of the prestigious *National Geographic Magazine* under the title *The Cone-Dwellers of Asia Minor.*

And it was the *National Geographic Magazine* which again, twenty years later, in 1939, published a splendid photographic article by the magazine's own correspondent, Whiting. It was entitled *Where early Christians lived in cones of rock,* and is considered the prototype of numerous photographic articles which appeared in travel and tourism magazines many years later – particularly in the 1980s.

The onset of the Second World War brought research to a complete standstill and, with all more reason, publications of an informative nature ceased.

Recovery finally began in the 1950s: it is worth recalling that a booklet of a general and informative nature was published in 1955 by the Ankara General Tourism Directorate entitled *Les Merveilles de Cappadoce* and was a sign of future touristic developments. Still in 1955, *Bilder aus Anatolien: Holen und Hane in Kappadokien* by Holzmeister was published in Vienna, but the truly significant year for the diffusion of knowledge of Cappadocia was 1958.

This was the year when *L'Universo*, a geographical magazine, published a long article by Turri: *La Valle di Ürgüp in Cappadocia e gli antichi monasteri cristiani*, which gave an extensive and detailed account of the geographical, geomorphological, historical and ethnographical characteristics of the locality.

Of particular interest was the part dealing with the erosion phenomena that have generated the extraordinary rock formations which characterize the region.

In the same year, the *National Geographic* again took up the theme – for the third time, after a lapse of some twenty years – of the rock cones, by publishing a photographic article by Marc Ribaud, with magnificent colour illustrations, entitled *Cappadocia: Turkey's country of cones.*

Again in 1958, an illustrated book was published in Germany under the title *Göreme: Holenkirchen in Kappadokien* by Budde and with photographs by Schamoni, which form the book's main interest, and which well testify to the curiosity aroused by the Cappadocia "phenomena" in the public, which no longer consisted solely of those with a working interest in the subject.

The following year the churches and paintings of Göreme were to have their first international film presentation. In 1959, in fact, the documentary *Colours in the Dark* by Ipsiroglu and Eyuboglu of Istanbul University was presented at the second international review of the Gran Premio Bergamo. Although the documentary was intended to be purely descriptive and instructive, it was well received by the more attentive critics and reached a varied audience.

However, ten years were to pass before Cappadocia was to become acquainted with the deeds of a film script-writer and emerge as one of the most fantastic settings for Pier Paolo Pasolini's *Medea,* with Maria Callas in the lead role. That film, an Italo-French-German co-production made in the summer of 1969, contributed to making those incredible landscapes known throughout the whole of Europe.

As further confirmation of the growing interest in Cappadocia, mention should be made of yet another article published in 1970 by the *National Geographic Magazine* entitled *Keeping house in a Cappadocian cave.*

Soon after, in 1971, the prestigious and richly illustrated *Arts of Cappadocia* was published for Editions Nagel, representing the point of arrival for all literature on the subject and having the merit of organically combining historical, religious, artistic, geographical, morphological and geological studies, and which included an extensive inventory of archaeological and monumental items in the entire region. The principal merit of this work by Giovannini, in which specialists from various sectors collaborated, is that it was written for readers who though cultured, did not necessarily have to have a working involvement in the subject, while at the same time providing an overall picture in a form which was both easily accessible and yet scientific.

Finally, mention should be made of another book published a little earlier (with Turkish and German texts) by the *Turkiye Turing ve Otomobil Kurumu,* written by Sigfrid and Hartmut Geerken under the title *Göreme Kılavazu.* Although extremely concise, the book is well documented – a quality that many of the guide books issued in subsequent years failed to achieve.

In parallel with these, an interesting volume was published in several editions and various languages from 1978 onwards. This was an archaeological guide to Cappadocia written by Elford (1976), who has also recently written *Cappadocia and the secret cities* (Elford, 1993). Besides being a well-documented, informative work, it is also an excellent guidebook for the more cultured and demanding tourist.

This brief review, which is obviously incomplete and restricted to a few "examples" (particularly for magazines, for which it would be interesting to carry out a systematic research) bears witness to and charts the gradual spread of knowledge of Cappadocia throughout the western world from the 1950s to the 1970s; this spread of knowledge was promptly matched by an increase in the development of tourism.

The figures confirm this: in fact, from the ca. 10 000 presences recorded in the Göreme area in 1965 the figure increased to approximately 60 000 in 1975, and was destined to grow dizzily in the following years, peaking at about 160 000 in 1978 before falling to 105 000 in 1984.

3. PLAN FOR THE DEVELOPMENT OF TOURISM AND PROJECTS TO CONSERVE CHURCHES AND PAINTINGS

Let us now examine the evolution of the problem of protecting and restoring the cultural heritage of Cappadocia, and in particular the Göreme area, beginning with the UNESCO mission. In that mission, the author was responsible for "studying selected ancient monuments in the Cappadocia area and drawing up suitable plans for their preservation and/or restoration, especially with a view to the use of such monuments in developing cultural tourism" (Sanpaolesi *et al.,* 1966).

First, it must be pointed out that after handing over our report in September 1966 I have had no further direct contacts with either Turkish government agencies or UNESCO. My knowledge therefore derives from information obtained from publications on the subject.

While apologizing for any – regrettably inevitable – omissions, I shall indicate only the significant stages which are necessary to understanding my conclusions.

In 1965 a study was made by the Ministry of Tourism on the development of tourism in the Province of Neveshir (Turism, 1965), in which an initial indication was given of the Göreme protection area perimeter. On 23 February 1973, the Turkish government issued a decree declaring that Cappadocia was a "Region of major importance in touristic development."

During the same year the Council of Europe launched a European programme of "Pilot Projects," essentially operative in nature, which was to be the Council of Europe's most important contribution to the European Architectural Heritage Year in 1975. Of the 50 projects selected, the plan for the Göreme Historical National Park was one of two selected for Turkey (the other was that for Istanbul). The plan's presentation sheet read as follows:

> "The Turkish government has undertaken to create the Göreme Historical National Park following studies carried out by a team of specialists in 1967 and revised in 1971. These studies concerned works for the conservation of the landscape and the artistic and architectural heritage of Göreme.
>
> The plan envisages:
>
> - control of land utilization and regulation of constructions by the Ministry for the Reconstruction and Development of National Parks;
> - restoration of churches and frescoes by the Turkish government with scientific assistance from UNESCO and ICCROM; and
> - restoration of six important caravanserais by the General Directorate of Vakif.
>
> The plan furthermore envisages the protection of two villages whose architectural heritage is an essential part of the park landscape. In anticipation of a detailed project, a systematic inventory of the buildings will be undertaken. From a juridical point of view the competent authorities will apply existing town planning and building legislation. The study of new legislation for protection of the park is however underway. Financing will be provided by the State."
>
> (Conseil de l'Europe, 1973)

The other stages are well-known: in 1980 the 21st General UNESCO Conference passed resolution № 4.12, authorizing the General Director to undertake the necessary technical studies for establishing a detailed plan of action and methods for promoting an "international campaign" to be launched in May 1983. In October 1982, the Council of Ministers ratified and passed as a "National Project" the "Structural Conservation Project of Göreme" drawn up in collaboration with UNESCO.

The objectives of the project were as follows:

- "To prevent the continued erosion of the historical monuments in the Göreme valley caused by natural and human factors before it makes restoration activities impossible.
- To prepare the region for long-term tourist activities.
- To continue the project for the restoration and conservation of the frescoes as well as that of the rock-hewn churches.
- To prevent damage caused by humans and to provide long-term protection for the tourist potential of the region, while ensuring that a maximum number of tourists can visit the region. Moreover, to provide appropriate tourist services along the sightseeing route through environmental works and daily service units.
- To establish the organization of skilled manpower in the project with a view to applying methods and technology developed in a systematic way."

(UNESCO, 1986(?))

During the development stages of this project, the foundations were laid for setting up the Göreme Open Air Museum, and in 1985 the Göreme Historical National Park was entered in the World Heritage List in recognition of its cultural and natural characteristics.

Leaving aside the undoubtedly significant restoration work, which has been carried out in collaboration with ICCROM from 1973 until the present day, and on which others will be in a better position than I am to report to this seminar, let us now turn to the current points at issue, namely to the long-outstanding and unresolved problems, but above all to the consequences of touristic development, which has perhaps gone beyond all reasonable expectations.

In the absence of more recent data, I shall take as a point of reference N. Thierry's paper on "Destruction of the sites and mural paintings of Cappadocia: natural and human causes" presented at the *European Symposium: Science, Technology and European Cultural Heritage* (Bologna, Italy, 13-16 June 1989). Various circumstances, which are, to say the least, alarming, emerge from this paper, namely:

1. Destruction of sites, landscape and historical centres caused by poor and uncontrolled urban planning.
2. Destruction of rural environment due directly or indirectly to mass tourism, particularly as a result of transformations induced by the latter.
3. Destruction of paintings due to an excessive number of visitors, creating problems of chemical aggression (humidity and carbon dioxide), vandalism, etc., in closed church environments.

In this regard, Thierry makes various suggestions, including that of drastically reducing the number of visitors and closing all churches which cannot be directly supervised, if necessary by bricking-up the openings. Thierry adds that copies of those churches which are most representative of the evolution of Byzantine art could be shown to the mass public, following the example of the Lascaux grotto in Dordogne, France, where sightseeing visits to the caves themselves were suspended in 1963 and an information centre set up instead that has non-stop projection of coloured reproductions of the precious wall paintings.

4. CONCLUSIONS

I can but only fully share Thierry's preoccupations, particularly since all those situations had been predicted in our report (Sanpaolesi *et al.*, 1966), in which we emphasized the necessity of avoiding every possible form of degradation which such intense forms of touristic exploitation can bring about.

That report read as follows:

> "The extraordinary formations of Zelve, Peristrema Soganl1, Göreme, etc., can and must conserve their characteristic of being an artistic and natural wonder in order to conserve intact their attraction for tourists and value as a work of art.
>
> *And this can be achieved only if they are kept immune from touristic wear and tear.*

> It cannot be stressed strongly enough that a repetition of the examples of the Acropolis in Athens, Pompeii, Pestum, etc., where monuments are threatened with destruction through damage and degrading overcrowding, must be avoided.
>
> *With a definite plan of prevention for each individual Cappadocia site, it is possible to obtain results that would be unthinkable elsewhere."*

The objective is therefore not only to prevent frescoes from decaying but also to prevent degradation of the entire territorial system in which each element, either through the work of nature or that of man, or even – as in the case of the rock structures – a combination of the two, is equally important because it contributes to forming the overall value of the whole system.

The problem is therefore inherently complex and partial solutions certainly cannot solve it in full.

In the 1966 report (Sanpaolesi *et al.*, 1966), it had already been pointed out that:

> "... it is necessary to study a way of showing church interiors to tourists without allowing them free access (without even considering acts of vandalism), since by merely touching or leaning on the walls they damage the pictures."

In addition, in reference to the conservation of the formal integrity of historic centres, it was stated that:

> "... precise regulations are needed in order to prevent new construction works, dissimilar as far as size and materials used, irremediably altering the characteristic appearance of these centres and that of the entire landscape to which they are so closely linked."

Finally, for the rural environment, general indications were given regarding vegetation, regulation of surface waters, management of crops and agricultural practice in general.

It was also pointed out that tourists should proceed only along routes provided expressly for the purpose (as should always be the case on archaeological sites) fitted with special flooring, footbridges, etc., and should always be accompanied only by guides belonging to the park or museum management organization.

I must, however, emphasize that in the project presented in 1973 to the Council of Europe, and particularly in the project drawn up in 1982, the view taken of the problems and the project approach was correct.

However, the fact that these projects have not produced the desired results obviously means that something has not functioned. That "something" – in my opinion – should be sought in the conceptual approach to these projects rather than in their technical elaboration.

My impression is that the technical side has been overestimated to the detriment of organizational and managerial aspects and that, in spite of everything, no due consideration has been given to what must be considered a fundamental assumption in these cases, and which can be summarized as follows: The development of tourism is based on the utilization of certain resources which consist of natural, historical and artistic heritages; this utilization is licit until it entails consumption of those resources.

If, however, tourism is allowed to consume those resources to the extent of destroying them, it is obvious that tourism will come to an end.

It is therefore necessary to find a balance between tourism development and conservation of the very resources which generate and sustain it, and which in this case consist of the natural heritage (geological and landscape) and the historical and artistic heritages, which embrace all the monuments present on the territory and, in particular, the rock settlements.

To achieve this result, a plan formulated on the basis of urban planning criteria is not sufficient, even though its objective is to conserve cultural property; instead it is necessary to aim at an articulated system of plans that will operate at different levels and in parallel in order to establish management methods for all operations involved in this planning system.

As an example, the idea of the National Historical Park, as conceived and supported by Sanpaolesi even before the 1966 UNESCO mission, is without doubt correct, but destined to fail if it remains as a zoning indication, albeit accompanied by technical regulations, but without the backing of a suitable management board with power of decision over all activities concerning the park itself.

In this connection it must be recalled that an initial outline of these management tasks was set out in the 1966 report: these were of course general ideas that required further elaboration but which substantially still remain valid.

The concept of the open air museum is also correct, but should be integrated with that of the historical park (which should perhaps be referred to as an archaeological site) with the introduction of an eco-museum concept. And here we begin to distinguish not just or not only independent elements within the same structure but different operational and managerial levels through which a single end purpose can be pursued. These intermediate levels should look for reference in a wider context, similar to what in Italy is known as the regional landscape plan, and should therefore cover the entire Cappadocia.

From a legislative point of view, I think that only through the issue of a special law can all this be achieved, since it has already been widely demonstrated that general legislation is not sufficient to solve such special and complex problems.

One aspect does not, however, appear to have been considered with sufficient attention – the relationship between these initiatives and the local population, who must become an active party in this delicate process.

Only in this way can we hope to achieve our objectives, bearing in mind, however, that at the basis of conservation there must be a process of awareness of its significance. In other words, broadly speaking, conservation is possible only through an initial operation aimed at educating and making people aware. Only then will each single restoration appear logical and justified.

One cannot rely on technology alone to achieve objectives of such import and uncommon dimensions: technology can achieve a great deal but it is necessary to ensure that the attitude and will of the whole society are invested too.

I realize that I have stretched the problem beyond the boundaries and limits of this seminar, but I am convinced that only by doing this can satisfactory solutions be found.

I shall conclude therefore by quoting the words of a philosopher who better than any other has an understanding of the significance and importance of what technicians refer to as integrated conservation, but which I prefer to define as "urban and environmental restoration" (Roselli, 1991).

> "Vana cosa, restaurare i monumenti di Venezia, se non si restaura la laguna (e restaurare vuol dire restituire alla laguna le acque confiscate dalla stoltezza industrializzatrice); e vana cosa restaurare la Cupola del Brunelleschi, se non si restituisce alla originaria vocazione agricola la 'Toscana tutta', che essa abbracciava." (Assunto, 1982)
>
> [Restoration of the monuments of Venice will be in vain without restoring the lagoon (and "restoring" means returning to the lagoon those waters confiscated in the name of unbridled industrialization); and restoration of Brunelleschi's Cupola will be in vain without restoring the whole of Tuscany, embraced by the Cupola, to its original agricultural vocation.]

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FROM THE GRAND TOUR TO THE PACKAGED TOUR: PRESERVATION, PRESENTATION, AND CONSUMPTION OF CULTURAL HERITAGE

M. Kirby TALLEY, Jr.

Abstract

Against a brief historical survey of the growth of tourism, the author discusses the confusion which can result in the presentation of cultural heritage when the approach followed makes use of two divergent principles at the same time: conservation/restoration, or the museological approach, and reconstruction, or the theme park approach. Some proposals in the 1971 **Göreme Master Plan** are reviewed in the context of the restoration and reconstruction of Colonial Williamsburg, Virginia.

"Whan that Aprill with his shoures soote/The droghte of March hath perced to the roote,/ ... /And smale foweles maken melodye,/That slepen al the nyght with open ey/(So priketh hem nature in hir courages)/Thanne longen folk to goon on pilgrimages," or in a more understandable English, "When in April the sweet showers fall/And pierce the drought of March to the root,/ ... /And the small fowl are making melody/That sleep away the night with open eye/(So nature pricks them and their heart engages)/Then people long to go on pilgrimages." [1] No other passage in the English language captures the urge of *Wanderlust* so joyfully as the opening of Chaucer's "General Prologue" to **The Canterbury Tales**. Who the first person was to get bitten by *Wanderlust* will forever remain a mystery, but it was undoubtedly someone who longed to go on a "pilgrimage," even if that was only to the hill behind their cave.

Travel was fairly common during Antiquity, at least for those who could afford it. The second century A.D. Greek traveller Pausanias has left us a mine of information in his 10-volume *Guide To Greece*, including route instructions. "There are two roads from Kleonai to Argos, one a short cut for an active man, the other over the TRETOS as they call it, narrow certainly, since it passes through the mountains, but all the same better fitted to wheeled traffic."[2] The clarity of Pausanias's instructions instils a

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premature confidence in the ease of travel in second-century Greece, until you pause over the words "an active man." Travel was not for the infirm or meek of heart. Roads during the Middle Ages could provide sudden and unpleasant surprises such as potholes large enough to accommodate horse and rider. A glover from Leighton Buzzard on his way to Aylesbury, England, in 1499 drowned in one along with his horse.[3]

Such perils, however, did not prevent hordes of pilgrims crowding the roads of medieval Europe on their way to Rome, Jerusalem, Canterbury, and St James at Compostella, among other destinations. As the religious motivation or excuse to travel slowly decreased so did the number of travellers, and such long journeys once again became the almost exclusive privilege of the well-to-do. The Grand Tour slowly emerged as an approach to travel during the seventeenth century, and by the eighteenth was *de rigueur* for gentlemen and milords. It was primarily an English phenomenon. Despite retinues which included cooks, butlers, physicians, tutors, coachmen and footmen, the Grand Tourists had to endure many discomforts and dangers. James Boswell, Dr Johnson's biographer, travelled extensively throughout Europe, but suffered from "beasts," or body lice, when he was in Rome in 1765, and later that year complained that French inns "are seldom good, for the rooms are cold and comfortless and dirty, the sheets damp, and snuffers difficult to be found."[4]

Even though conditions of travel had improved considerably since Chaucer's pilgrims set out for Canterbury near the end of the fourteenth century, transportation in the eighteenth century, even by the most luxurious coach, was still uncomfortable and exhausting. Crossing the Alps may have been a bit safer than when Hannibal first struggled over them, but the experience could still be harrowing. Boswell, like many travellers in those days, was carried over them on an "Alps machine," which was nothing more than "two trees between which were twisted some cords on which I sat."[5] Horace Walpole, son of the great Prime Minister, Robert, and a collector and antiquary of distinction, attempted to cross the Alps in far greater style than Boswell did, but his passage was tarnished by a minor disaster. He let his pet King Charles's spaniel, Tory, out of the coach for a walk only to see the dog carried away by a wolf. In a letter to Richard West, Walpole sadly noted, "It was shocking to see anything one loved run away with to so horrid a death."[6]

However, despite bugs, bandits, bad roads, damp sheets, lousy food and strange customs, the Grand Tourists kept going on long and often perilous journeys to see the sights and buy *objets d'art*, paintings, furniture, clothing and other luxury goods to enrich their homes, wardrobes, and collections. Although the Grand Tour was more or less a "must" for social prestige, many, if not most, Grand Tourists took the event seriously. A great deal of time was spent not only in seeing the sights, but also learning about them. Tutors and cicerones were employed to instruct the young gentlemen and milords in history, architecture, painting and sculpture. For many travellers, therefore, the Grand Tour was a sort of movable seminar conducted before the objects and sights themselves rather than in a classroom.

Travel, at least at the top end of the market, can still confer prestige upon those fortunate enough to be able to afford it. It can also be highly instructive and provide serious information on the sights seen. For example, in Scotland one can take a week's train trip around the highlands, stopping for lunch with the local duke or marquess, visiting other country houses with or without their owners being present, and constantly passing through some of the most spectacular countryside in the world. A highly trained guide who knows the history of the country and all the sights to be seen during the week accompanies the group at all times and takes meals with these modern-day Grand Tourists as well. The train, as I understand it, makes the Orient Express look a trifle shabby and the French chef on board has four Michelin stars on his cap. All of this can be enjoyed for the modest sum of UK£ 5 000 for the week. Travel to Scotland is extra.

Of course, excursions like this one are exceptional and will remain the domain of the rich. If the tourist industry had to depend on this type of travel for its existence it would not be the number two industry in the world, after the oil business, which it has become. The roads and skies have become crowded as they have never been before with that contemporary successor to the pilgrim, the Packaged Tourist. For a relatively affordable sum one can now "do" Europe in two weeks or less, "do" the Far East, "do" Africa or India, or simply "get away" to that paradise of a seaside resort on the Costa del Sol or on some island in the Pacific or Caribbean or wherever there is sand and water and sun and a hotel.

Nothing is to be gained by being snobbish about all this economy travel which makes mass migrations of tourists possible. All of us are prone, in varying degrees, to *Wanderlust.* Travel can be both fun and an educational enhancement to our lives. For it to be the latter, however, one must journey to one's destination with more baggage than a suitcase or two. Without a certain level of education – and that level will have to be fairly high if the experience is to be truly meaningful – the importance and relevance of our cultural heritage and the joy and enrichment it can provide our spiritual and intellectual lives will remain beyond our grasp. The general level of education the world over has declined during the past thirty years or so, at least the type of humanistic education which prepares people to understand, value, appreciate, and enjoy our cultural heritage in such a way that it becomes a vital and irreplaceable element in their lives. Regrettably, culture is too often looked upon as a luxury rather than the necessity it is, or should be, to all of us.

While we may deplore the deterioration of educational standards, there is precious little we, and our profession, can do about it. That is the task of educational authorities the world over. What we can do as a profession – and I include the curators and administrators – is to consider most seriously what cultural heritage institutions and phenomena in the broadest sense of the term, such as museums, archaeological and heritage sites, national parks, historic city centres, and the like, for which we are responsible in our various capacities, can do to make a visit, even a casual one, a meaningful experience – one worth the effort and expense, and one worth remembering. The tourist industry also has an important role to play in offering acceptable alternatives to the "real" experience.

This, of course, implies a tiered approach, a sort of class system, to tourism. It already exists, as we all know, and while it may be fashionable among prigs and culture snobs to pooh-pooh theme parks, and the like, as being fakes and kitsch, they serve an important purpose in the contemporary recreation market.[7] The EuroDisney Resort near Paris may provide its greatest service in reducing the numbers of casual tourists to Paris. People are told they *have* to see Notre Dame, or the Forum Romanum, or the Parthenon, or Angkor Wat, or the Forbidden City, or Göreme. Why? So they can say they have seen it? Or perhaps more to the point, so they can photograph or video it. In our supposedly democratic global village it does not do to be too precise on who is fit and who is not to enjoy the genuine heritage experience as opposed to an evocation to it. And it must be admitted that making such an infallible distinction in reality, as opposed to theoretically, is virtually impossible if you believe, as I do, that beautiful and remarkable things can and do inspire people, even people who are totally ignorant of what they are looking at.

Since there is no reason whatsoever to believe that the numbers of tourists will do anything but increase in the future, some form of acceptable tourist segregation will have to be found if we are to entertain even a modicum of hope that we will be successful in our uncoordinated, underfunded and understaffed attempts the world over to preserve even a small part of our common cultural heritage.[8] We cannot continue to operate on the assumption that everything we understand under the term cultural heritage must be open and available to anyone who happens to come along and wants to see it. For a long time, the professionals have known that we are dealing with a limited resource. Over-use will ultimately destroy it. A monument like Versailles, with its three-and-a-half million visitors a year, is a perfect example. It is literally in danger of disintegrating. Testing people on what they know about a specific monument or church or collection and making admission dependent on their grade is simply not practical. And institutions like the Supreme Court of the United States would have fun sorting out the legality of such procedures. Raising admission fees, however, is both practical and realistic and Robertson Collins, Chairman of the ICOMOS Committee on Cultural Tourism, and a noted authority on the subject, cited an initiative in Sri Lanka as an example of how we might approach the problem. Admission fees from heritage sites go into a fund which is used for conservation.[9] Such a system has a double spin-off. Numbers of visitors, thus wear and tear, are decreased while revenue, especially for maintenance, is increased.

While the tourist is too often seen as the villain by the conservation community, the community itself, including curators and administrators, shares a great responsibility for initiatives which in the long run can distort or destroy our cultural heritage much more quickly and more definitely than busloads of tourists. It is not my purpose to come to Göreme to criticize your plans to create a historical national park. To do so would be presumptuous on my part since I am only familiar with the revised 1971 version of your Master Plan. I have not yet seen the results of your initiative. Perhaps some of the proposals, which I am going to discuss in the context of other projects elsewhere, were never carried out. But there are several issues raised in your 1971 Master Plan which are highly relevant to a general discussion on the principles which should guide our approach to the preservation and presentation of our cultural heritage.

That an area like the Göreme Historical National Park should and must be protected is obvious. How one does that effectively and at the same time allows life to go on in a normal, non-artificial manner is the problem. In the 1971 Master Plan it was proposed to preserve the architecture "unique to the Cappadocia region" while demolishing houses which "are located out of context with the village pattern and are of an entirely different architectural style."[10] Such a decision, which is quite common to architectural restoration whether it be a single building or a city centre, has far-reaching consequences. It comes from a desire to freeze a particular stylistic situation, considered aesthetically superior to either what preceded or followed it, into perpetuity.

One of the most remarkable restoration projects carried out in this century was the restoration and reconstruction of Colonial Williamsburg in Virginia. When Mr John D. Rockefeller, Jr. wrote out a cheque to the sum of US$ 100 000 000.00 in 1927, an initiative began which is still underway. The major work, however, was completed by 1935, and by that time, so the report tells, "Some 440 buildings of late construction have been torn down and 18 moved outside the Colonial area; 66 Colonial buildings have been repaired or restored; 84 have been reproduced upon Colonial foundations. Federal Highway 60 has been diverted to a by-pass road, and streets, open spaces and gardens have resumed their Colonial appearance, with lamp-posts, fences, brick walls, street surfaces and plantings derived from authentic records."[11] A very clearly defined *modus operandi* was set down in the decalogue, or Ten Commandments, governing the approach to be followed by the Williamsburg restoration architects. Nº 3 states, "That within the 'Restoration Area' all work which no longer represents Colonial or Classical tradition should be demolished or removed."[12] At least this leaves no room for any misunderstanding.

It is hard to be too critical of Colonial Williamsburg since the results are both so stunning and so pleasing. If one reads the literature on the restoration, no doubt can exist that the utmost care was expended to be "archaeological" about both the restoration of existing buildings and the reconstruction of those lost. In 1966, I was given a fascinating tour of Williamsburg by one of the architects involved in its restoration and I remember him commenting on the Governor's Palace, one of the reconstructions, that it was beginning to look quite nice now that it was putting on some age.

Williamsburg ceased being Virginia's capital in 1779; it ceased being a real town in 1927 when Mr. Rockefeller wrote out his cheque. What was gained in this instance, namely the preservation of many original buildings which would probably have been lost, outweighs, I believe, what was lost. But something was definitely lost – reality. The preservation and eventual restoration of our cultural heritage is one thing; its reconstruction quite another. The former belongs to the sphere of the museological approach, the latter to that realm of theme park fantasy – what Peter Cannon-Brookes, editor of *Museum Management and Curatorship*, has dubbed the "heritage experience."[13] In a place like Williamsburg these two vastly different approaches are wedded in such a way that, no matter how conscientious the curators are in explaining the reconstructions, people cannot help leaving with a distorted impression of this charming eighteenth-*cum*-twentieth-century village. Since Williamsburg was only founded in 1699, there would have been a greater uniformity of architectural style during the eighteenth century than would have been the case had the town dated from 1500. This situation was particular to the newness of the Colonies, and in this respect Colonial Williamsburg cannot be charged with completely faking the cityscape by concentrating on its eighteenth-century appearance.

But Williamsburg lived on during the nineteenth century. By then the Palace had disappeared, having burnt in 1781, and the second Capitol building burnt in 1832. More buildings were lost and others were constructed to replace them or add to the town. What was torn down by the restoration architects in 1927 may not have seemed very interesting to them at that time, but today we would undoubtedly think differently about a house dating from 1860. Nineteenth-century Williamsburg belongs as much to the American cultural heritage as does eighteenth-century Williamsburg, even if it is less interesting historically, or less pleasing aesthetically. What was, was, and removing it can only result in a distortion, no matter how delightful the results may be. While the restoration architects were very clear on what had to be removed, they were less consistent as to what had to be re-constructed. Among the buildings reproduced in Williamsburg up to 1966 you will not find the whore house which used to stand on the corner of South Henry Street and Duke of Gloucester Street. The restoration architect who gave me the tour told me the Williamsburg Restoration authorities decided to put a parking lot over the place where this building once stood. Presumably, it was too much for them to admit that the Founding Fathers could ever have frequented the place. And yet, I would wager that if a re-constructed whore house had been included it would have been one of the more popular attractions. Perhaps it has been put up since 1966, the last time I visited Williamsburg.

What Williamsburg should teach us is that it is a precarious business indeed to embark upon restoration and reconstruction on such a scale in a "living" environment. Real life, of course, disappeared in Williamsburg, and the results are neither pure museum nor pure theme park, but the theme park element definitely dominates. The same danger exists in the 1971 Master Plan for Göreme where, at least before that year, people lived in historic surroundings but continued, as they had done in the past, to add to them. That their additions may seem "visually unsympathetic" to our eyes does not mean that they are so in the eyes of the people who built and use them.[14] What we admire in historical Göreme was created by their ancestors. Tomorrow's history will have been created by the present inhabitants. In such a project the experts should be very careful before imposing their norms – which concentrate quite often primarily on an academically ideal historical situation – upon an indigenous population. One can ask, for whom Göreme? An ideal answer would be for both the natives and visitors in their own respective ways. We all know, though, that it is never that simple, whether it be the Navaho Indian reservation at Monument Valley, Utah, or Florence, Italy. Once the visitors come in numbers a certain element of "normal" life which existed before their arrival is lost forever and will never be re-captured. Since I have not yet been to Göreme I am interested to see if you have indeed succeeded in ensuring that "The life of the inhabitants must not be permitted to become role playing nor the village a sterile museum of houses or a collection of commercial tourist traps."[15] I certainly hope so, first and foremost for the inhabitants, and secondly for the tourists who, when they specifically come to see the real thing, should be able, as far as possible, to see the real thing.

Williamsburg, as fine as it is, as enjoyable as it is, as instructive as it is, remains an important and still largely unheeded lesson for the conservation and museum communities. No matter how scholarly or archaeological the research and approach may be, it is impossible to make a "real" thing from a reconstruction. When, however, the attempt is made in a real environment, the result is a deceitful bastard – half genuine, half fake. To be fair it must be clearly stated that the Williamsburg authorities have never attempted to pretend that what was replaced after 1927 was the real McCoy. My problem is with the confusion which can result when you mix two such totally divergent principles, thereby causing a bastardization. But on the subject of bastards I must admit that many of the ones I have known have had a way of being extremely charming and amusing, and some of them have even been highly instructive. I hope I am neither a prig nor a culture snob, but as a tourist – and I am as much one as all the others – I have often enjoyed the heritage "bastards" I have encountered during my travels.

FOOTNOTES

1. *The Works of Geoffrey Chaucer*, edited by F.N. Robinson (Boston: Houghton Mifflin Company, 1961), p. 17; and Geoffrey Chaucer, *The Canterbury Tales,* translated by Nevill Coghill (Baltimore: Penguin Books, 1959), p. 17.

2. Pausanias, *Guide To Greece*, translation and introduction by Peter Levi. 2 vols. (Harmondsworth: Penguin Books, 1979), I, p. 164.

3. See G.G. Coulton, *Medieval Panorama* (New York: World Publishing Company, 1961), pp. 323-324.

4. *Boswell on the Grand Tour: Italy, Corsica, and France 1765-1766*, edited by Frank Brady and Frederick A. Pottle (London: William Heinemann Ltd, 1955), p. 252. See p. 78 for his "beasts."

5. *Ibid.*, p. 23.

6. *Horace Walpole's Correspondence*, ed. by W.S. Lewis *et al.*, XIII (New Haven: Yale University Press, 1948), p. 190.

7. See Peter Cannon-Brookes' editorial: Museums, Theme Parks and Heritage Experiences, *Museum Management and Curatorship,* **10**(1991): 351-358, for a perceptive and realistic discussion of this issue.

8. See the two brochures "World Tourism, 1970-1992," and "International Tourism in Europe, 1970-1992," published in January 1993 by the World Tourism Organization, Madrid, Spain, for facts and figures.

9. Robertson E. Collins, typescript of speech, "Heritage Conservation and Tourism," given at the 6th International Conference of National Trusts, 1 December 1993, p. 9.

10. *Göreme Historical National Park: Master Plan for Protection and Use*, revised version, 1971, pp. 26-27.

11. *The Restoration of Colonial Williamsburg in Virginia*, reprinted from *The Architectural Record*, December 1935: 357.

12. *Ibid.*, p. 370.

13. See footnote 7.

14. *Göreme Master Plan*, p. 27.

15. *Ibid.*, p. 28.

CONSERVATION MANAGEMENT OF WORLD CULTURAL HERITAGE SITES

Jukka JOKILEHTO

This paper is based principally on the ICCROM publication by Feilden, B.M., and Jokilehto, J., *Management Guidelines for World Cultural Heritage Sites*. ICCROM, Rome, 1993.

SUMMARY OF GUIDING PRINCIPLES

Management of cultural heritage sites may require different levels of technical sophistication, but should be used to raise levels of technical competence. Priority should be given to establishing a framework for management, and a plan consisting of interrelated resource project plans. All proposed activities should be based on interdisciplinary collaboration using conservation theory to evaluate alternative proposals.

The management of a heritage site is based on a detailed analysis of its significance, and should address the following issues:

- ensuring that all staff understand the cultural values to be preserved in the site;
- providing specific guidelines based upon the statement of significance of the site;
- making a complete inventory of all cultural heritage resources within the site;
- arranging for regular inspections and formal reports by qualified professionals;
- drafting a strategic maintenance plan and resource projects within an annual programme; and
- respecting, in all work, the essence of established international recommendations.

It is essential to prepare an inventory and document, in an appropriate manner, the history and the present condition of the site as well as all treatments. All projects should be prioritized with due reference to long-term, medium-term and annual work plans,

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integrated with a system of inspections and reporting. A properly monitored preventive maintenance strategy is a basic tool for management, and should be based upon a multi-disciplinary approach. All personnel should be properly trained. It is also recommended that a *Site Commission* be established with responsibility to act as a guardian of the site. In some cases, several sites could be under the care of one Commission.

WORLD HERITAGE CONVENTION

In December, 1992, in Santa Fe, more than 130 States Parties celebrated the twentieth anniversary of the *Convention concerning the Protection of the World Cultural and Natural Heritage*. This Convention, adopted in November 1972, has become the most popular international instrument created so far by UNESCO, and involves not only the States that are Parties to the Convention, but also several international bodies, especially ICCROM, ICOMOS and IUCN, for joint action to protect and conserve the world's cultural and natural heritage. The Convention is also significant because it places culture and nature together, thus providing a basic reference for a new international strategy in this era of sustainable development.

UNESCO Conventions and Recommendations need to be seen together as a declaration of the international community who recognize the values of the cultural and natural heritage of humankind and the necessity to take specific measures to guarantee its conservation (UNESCO, *Conventions and Recommendations of UNESCO concerning the protection of the cultural heritage*. Paris, 1985). The World Heritage Convention, in particular, recognizes the "outstanding universal value" of this heritage. Each State Party to the Convention recognizes the duty to ensure protection of this heritage, and, at the same time, the international community as a whole co-operate to provide the necessary support for each party in carrying out their duty.

For this purpose, the Convention has formed specific tools: these include the *World Heritage List* of properties that fulfil the necessary criteria to be recognized as World Heritage Sites, and the *World Heritage Committee*. The latter is an intergovernmental committee established within UNESCO, and formed of elected representatives of States Parties. The Committee is responsible for seeing that the intentions of the Convention are carried out. The Parties to the Convention are required to pay contributions to an international fund, the *World Heritage Fund*, from which assistance may be yearly provided for the management of the sites that have been included on the List, including, in particular, training of site managers and conservators, as well as technical co-operation, missions and equipment. The co-ordination and administration of the work is guaranteed by the *World Heritage Centre*, the secretariat to the Convention at UNESCO, in collaboration with the statutory advisers: ICCROM and ICOMOS for cultural heritage, and IUCN for natural heritage.

PROCESS FOR LISTING

The intentions of the Convention are translated by the World Heritage Committee into rules and guidelines, expressed in the *Operational Guidelines*, which may be updated to respond to the evolving requirements of the protection. The initiative for listing lies with the States Parties, who are expected first to propose comparative *Tentative Lists* of potential properties on their territories. Subsequently, in collaboration with the advisory bodies, sites will be selected to be presented for nomination by the World Heritage Committee.

The criteria for defining the "outstanding universal value" of cultural heritage sites are specified in the *Operational Guidelines* and include six basic points. These range from a unique artistic achievement to outstanding examples of types of buildings, architectural ensembles, or landscapes which illustrate significant stages in human history, have exerted great influence or bear a unique or exceptional testimony to a civilization. In relation to historic towns or urban ensembles, there are specific criteria that specify the different types of towns that may be taken into consideration, including archaeological areas, historic inhabited towns, and new towns of the twentieth century. In addition, there are specific requirements of historic authenticity, as well as of adequate legal protection and management mechanisms at the national and local level to ensure the conservation of the nominated property. The evaluation of the proposed nominations are carried out by ICOMOS for cultural and by IUCN for natural properties before these are presented for the approval of the World Heritage Committee.

First nominations to the List were made in 1978; since then the number has gradually increased, reaching 378 by December 1992 [411 by January 1994], of which 276 are cultural heritage sites and 15 mixed sites. The cultural heritage sites represent a great variety of types of resources on the different continents, including architectural works, works of monumental sculpture and painting, groups of buildings, historic cities, archaeological sites, as well as "combined works of nature and of man," such as cultural landscapes.

FOLLOW-UP PROCESS

The aim of the Convention in establishing international protection of the world's heritage is understood to mean the establishment of a system of international co-operation and assistance to support States Parties in their efforts to conserve that heritage (Article 7). In fact, it is the duty of each State Party to ensure "*the identification, protection, conservation, presentation and transmission to future generations*" of the heritage that has been nominated to the List. At the same time, it is the task of the international community to give a hand to State authorities to help them in this task.

Assistance may take various forms, including international meetings or seminars to exchange views on specific questions related to conservation and management of sites, and by training conservators and managers who are responsible for the maintenance, conservation and development of the sites and the context of which these are part. It may also be done in the form of technical assistance by providing specific technical instruments or materials necessary for conservation work on the site.

At the same time, it has been agreed that each State Party will regularly keep the international community aware of the state of conservation of the listed World Heritage Sites on its territory, indicating any restorations or improvements that are foreseen, any potential changes or disasters that threaten or have occurred, as well as any potential development programmes that might concern the site. The aim of this international networking and monitoring system is, on the one hand, to strengthen the position and professional know-how of national conservation authorities, and, on the other, to make it possible for the international community to provide expert advice or other assistance in time to avoid undesired transformations or destruction of the qualities and values for which the site has been recognized.

MANAGEMENT PROCESS

For each site or a group of sites, it is desirable to establish a process for management by resource projects: to identify and document the qualities and values of the resources, and to define the aims and priorities of conservation management. The aim is to build a team, a Site Commission, that will grow to the level of *total quality management*, and that will guarantee cyclic maintenance and timely repairs of the heritage resource, based on a critical process. The Site Commission should act as a guardian of the World Heritage site. Its primary duty is to conserve and manage the site. The form and name of the Commission should be dictated by practical considerations relevant to the national administrative pattern.

Particularly when dealing with reasonably large areas, Cultural Landscapes (such as the Göreme Valley) or historic towns, it is desirable that the Site Commission have the authority to manage not only the strictly conservation aspects of the site, but also to take into consideration and plan for the development of the area. This is vital in order to reach a balanced "symbiosis" in the economics of the site. Economic planning of cultural landscapes or historic urban areas should take into consideration the social structures and traditional life patterns of the communities concerned; in fact, sustainable development should be the fundamental basis for any economically healthy conservation management of heritage resources.

The conservation management process should include:

- survey and documentation of resources and the historical-ecological setting,
- definition and assessment of the site,
- scientific analysis and diagnosis, and
- preparation of long-term and short-term programmes for conservation management and sustainable development, including regular inspections, cyclic maintenance and environmental control, as well as management of visitor services and planning of the economics in relation to the regional or local context.

The first requirement of site management is the conservation and protection of its cultural resources and its integrity; where possible, the enhancement of features of special interest may be taken into account. Once conservation is guaranteed, depending on the type, quality and character of the site, it may have public uses, such as education, research, tourism and even occupation. Management plans need not be complicated or lengthy. Provided the main objectives are known and the site staff is properly qualified, resources can be managed on the basis of care and maintenance. In any case, the plans should be reviewed every 3 to 5 years to accommodate any necessary adjustments.

An annual management plan should consist of three main sections:

1. Description of the site: general information on the location, as well as relevant related information, e.g., about cultural, archaeological, art-historical, architectural, scientific, and environmental issues.
2. Evaluation and objectives of the Plan: the conservation status of the site, potential threats, definition and evaluation of site features and potential, cultural and economic values, operational objectives and management options.
3. Prescription for overall site management: identification and description of projects, work schedule, costs and staging of works.

Preventive maintenance should in most cases forestall the need for major interventions, and it has been well documented that good maintenance reduces the cost of conservation of historic resources. The maintenance programme is, in fact, aimed at keeping the cultural resources in a manner that will prevent the loss of any part of them. It concerns all practical and technical measures that should be taken to maintain the site in proper order. It is a continuous process, not a product. Maintenance should be programmed as a routine that covers daily, weekly, monthly, seasonal and annual tasks. To be efficient, it also needs to be locked in a system with proper inspection, reporting and documentation strategies; in addition, it requires properly instructed personnel.

The initial inspection of an historic building or site is of vital importance. This has to embrace the whole problem as comprehensively and quickly as possible. Inspections should be followed by careful research, analysis, recording, and necessary conservation action. The importance of reports is not just to inform authorities of the actions taken and the current needs, but it is also to form a reliable document for future reference and systematic monitoring, as well as to prepare for prevention of vandalism, theft and fire.

WHAT DO WE CONSERVE?

While all historic and artistic properties will have their qualities and values, the aim of the World Heritage List is to identify a representative number of properties of "*outstanding universal value*." In many cases, each site on the List in fact represents a whole class of heritage resources in the region concerned. For the purpose of understanding and evaluating the complexity of existing resources and their relations with each other, the Committee initiated, in 1990, a project called the *Global Study*.

The aim is to have a world map of the resources seen in relation to their cultural and historical context. The Convention is also accompanied by a *Recommendation concerning the protection, at national level, of the cultural and natural heritage*, also adopted in 1972. Both documents emphasize the need to adopt a general policy aiming at giving the heritage a function in the life of the community, and to develop necessary services, and research, administrative and training structures to provide appropriate support for conservation.

The "outstanding universal value" is identified through a process of historical-critical survey and evaluation, taking into account the significance of the site concerned in relation to other sites of similar type. In some cases the site really stands alone as a unique work of art, in others it is the most significant example of a class. One nomination may even consist of a selection of several sites (such as the Jesuit Missions of the Guaranis, of which four properties are in Argentina and one in Brazil) that together represent the "theme." Each nomination is of particular significance concerning the specific qualities and values for which it has been nominated.

The aim of conservation should therefore be to safeguard the quality and values of the heritage resource, protect its material substance and ensure its integrity for future generations.

It follows that conservation should be based on methodical survey and documentation, and clear definition of the heritage resource and its relationship to its setting. This definition is part of the critical process aimed at assessing resource values, establishing objectives for conservation management, and preparing presentation and interpretation policies and strategies for long-term and short-term programmes of action. In historic areas, concern is not only about the conservation of the material substance but also about the balance of human and socio-economic values in the area as a whole. In fact, when dealing with historic towns, villages or cultural landscapes, conservation needs to be challenged with the management of sustainable development and inevitable change in living areas. This requires defining the "limits of transformability" in each area.

Concerning treatment of a site in ruins, the primary purpose should be to safeguard its historic substance and present it to the public.

In all these cases, whatever the treatment of each individual resource or site, one of the primary concerns should be to see that the authenticity of the site be maintained. The Operational Guidelines of the Convention indicate four types of authenticities that should be taken into account when the site is listed: authenticity in materials, in workmanship, in design, and in setting. Of these, the first, i.e., authenticity in materials, is essential if the resource is to maintain its historical authenticity and its archaeological potential as an original resource with the values for which it has been nominated to the World Heritage List. There are, however, also authenticities that gain importance particularly when dealing with living continuity of traditions and ways of life. The continuity of traditional forms of land use, such as specific types of farming, is vital for the continuing existence of the identity of many regions and settlements - in Japan or India or Europe. To what degree this is possible and what the alternatives are is a question that needs to be posed when deciding about management policies for cultural landscapes and traditional settlements.

Conservation of cultural heritage is a complex issue that needs to take into account many variables and values. These include both *cultural values* and *contemporary socio-economic values*. Cultural values may be classified in a number of ways, such as *identity values* based on subjective recognition, *relative artistic or technical values* that are discovered through research, and on *rarity value* that can be understood through comparative research and inventory of heritage resources. The second group of values relates to economics, and therefore to resource management in general with the aim of fulfilling a wide range of needs, including *functional, educational, social and political values.*

The treatment of a site depends fundamentally on the assessment of these values. Even similar types of sites may justify different types of treatments depending on the cultural context, and the values that are attached to it. Many of these values, particularly contemporary socio-economic values, can have both positive and negative impacts on the resource, depending on the type of value and on the emphasis that is given to it in the overall assessment. For example, while educational values may be considered essential in a site, over-emphasis on tourism may lead to unjustified reconstructions, destruction of original fabric, and kitsch, thus causing a loss of archaeological potential and authenticity. Similarly, while a museum has a cultural function in society, "musealization" of a historic structure or sites will mean a new use for it. Therefore, due caution is needed not to lose the essence of the resource – and hence the aim of conservation.

TRADITIONAL SETTLEMENTS

Recent developments in many parts of the world have forcefully challenged the continuity of traditional communities, and the management of cultural heritage resources. This may be partly due to changes in administration, to finances or to changes in ownership; it is certainly due to general changes in production processes, as well as to the changing ambitions and the degree of cultural awareness of people. It is a question of recognizing the values and qualities of such heritage, and looking into the needs of the inhabitants against the background of sustainable human development. We realize today that progress needs to be based on the realistic development of existing resources, and this is true particularly when dealing with larger historic areas or provinces, traditional country towns, and entire cultural landscapes.

The concern for such historic areas is a world problem. An ICOMOS meeting in Itaipava, in Brazil, in July 1987, produced a series of recommendations which in many ways are relevant also to the European situation. Historic urban centres are recognized as "*critical areas*" in terms of their operational value. While recognized as part of the wider totality, these areas are enriched with values of remote or recent origin, and are permanently undergoing a dynamic process of successive transformations. Changes and further development in this historic context is not excluded, and *"new urban spaces may be considered as environmental evidences in their formative stages."* The Brazilian charter further states:

> "As a socially produced cultural expression, the city adds rather than subtracts. Built space, thus, is the physical result of a social productive process. Its replacement is not justified unless its socio-cultural potentialities are proven exhausted. Evaluation standards for replacement convenience should take into account the socio-cultural costs of the new environment."

The basis for any planning and intervention in an existing fabric is the knowledge and understanding of the resource concerned, in terms of both its history and its present condition. Therefore the starting point for conservation planning must be the identification, based on a careful study and analysis, of the historic fabric of the town. One of the objectives of urban conservation is to control the rate of change in the urban system. We therefore need to comprehend the life forces of that system and the potential causes of its decay. In an urban planning context, "revitalization" means the planning measures that are necessary to improve the social and economical activities of an historic area or an historic town, which has lost its original functional vitality and, as a consequence, historic buildings and urban spaces have become redundant and dilapidated. The aim of revitalization should be an appropriate balance between conservation and development. The closer the new use of the rehabilitated building is to its previous use, the less the work will cost and the better it is for the urban plan as a whole. New services should not be introduced into an historic area without a clear understanding of its ability to absorb, use and maintain them.

In most societies today, the traditional way of life is changing, and this produces, among other things, profound mutations in the character of towns, where the population is concentrated and contemporary culture seeks expression. Cities are the privileged victims of change and, for this reason, it is increasingly necessary to manage change; this is the challenge that confronts their administrations. In order to be able to do such management, it will be necessary to have carried out a systematic study of building typology, condition, use and occupancy, as well as identification of economic causes of growth and decay. As well, it will be essential to take care of property management with regular inspections, and a maintenance strategy including control of external painting and decoration. It is recommended, in general, to opt for modest rehabilitation schemes, rather than ambitious ones, and to allow for social input and consultation with occupants.

In the case of vernacular architecture, which often consists of short-lived or vulnerable materials (such as reeds, mud, rammed earth, unbaked bricks and wood), the same type of materials and traditional skills should be used for the repair or restoration of worn or decayed parts. Conservation of cultural heritage, particularly when dealing with larger urban or rural areas, is now recognized as resting within the general field of environmental and cultural development. Sustainable management strategies for change which respect cultural heritage require the integration of conservation attitudes with contemporary economic and social goals, including tourism.

ZONING AND ENVIRONMENTAL MANAGEMENT PLAN (ZEMP) FOR THE ANGKOR WORLD CULTURAL HERITAGE SITE, CAMBODIA - A CASE STUDY

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ABSTRACT

Angkor contains the spectacular remains of several capital cities of the Khmer Empire which flourished in the ninth to fifteenth centuries. The area was recently inscribed on the World Cultural Heritage List. A condition of inscription is the adoption of a zoning plan and legal framework for protection and management. The proposed plan focuses on sustainable development of natural and cultural resources to achieve a balance between archaeological protection, tourism, and urban and rural development. Aerial photography interpretation and a geographical information system (GIS) were used in the generation of zones and management policies. The main sites and monuments are identified as national protected cultural sites within an extensive protection zone – the Siem Reap-Angkor Region. A national Angkor authority is to be established by the government to manage the protected sites and regulate the impacts of tourism and other developments on archaeology and the World Cultural Heritage Site.

INTRODUCTION

This paper is based on the work of the Zoning and Environmental Management Plan for Angkor (ZEMP) (UNESCO, in press). It outlines the importance of Angkor as a World Cultural Heritage Site and discusses the planning and management issues, many of which are common to other extensive World Cultural Heritage Sites, such as Göreme. The paper concludes with lessons from the ZEMP experience.

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WHAT IS ANGKOR?

Angkor is a series of capital cities situated on the plain between the Phnom Kulen hills and the Great Lake – Tonle Sap – in northwest Cambodia. The ancient metropolitan centres were constructed between the eighth and thirteenth centuries in an area where permanent rivers flow from the forested upland across the flat alluvial plain to the lake, an area of more than 5 000 km^2. Throughout this area are found the remains of religious monuments, fortifications, water tanks, roads, bridges and other public works built by the ancient Khmers. Recent archaeological surveys have shown that the region was occupied before the establishment of the Angkorian cities. As the wealth of the Khmer kingdoms grew, a succession of "King of Kings" chose to live in and around Ankgor; the most successful extended their Empire over much of Indo-China and what is now northern Thailand, and to the Malay Peninsula.

Khmer architecture was inspired by Indian models, both Buddhist and Hindu. However, the ancient Khmer civilization developed its own art, architecture and spatial organization, as vividly demonstrated in the religious monuments of Angkor and in the design of the cities and the landscapes. The kings built elaborate temples to their gods and decorated them with reliefs. They also developed extensive hydrological systems to manage water for irrigation and to supply the urban and temple complexes. Rivers were straightened into canals and vast storage reservoirs, called *barays,* were created behind embankments. Dikes were built across the flood plain to deflect and retain water to irrigate crops. The annual rise and fall of Tonle Sap was exploited to grow first floating rice on the rising flood and then receding rice as the waters subsided. Massive blocks of sandstone were quarried in the nearby hills and shipped by land and water to the city sites to construct temples.

The outstanding monument of Angkor Wat (mid-twelfth century) has a wall and moat 5.5 km long. The central temple rises to over 55 m in height. Angkor Thom, the largest and last of the cities, is formed in a square and surrounded by a wall 8 m high, with a moat 12 km long. At its height, Angkor Thom may have held over one million inhabitants, who would have depended on a large suburban hinterland. However, no archaeological remains of the domestic buildings have yet been recovered, as these were constructed of timber and have rotted in the humid tropical conditions.

During the past 100 years, archaeological research has concentrated on the architecture and the historic, symbolic and religious aspects of the period. Archaeologists, however, anticipate that a wealth of information lies buried underground. New evidence is being discovered of the extent and density of the Angkor archaeological remains, but much detail of the pre-Angkorian and Angkorian civilizations remains to be discovered.

Stimulated by the nineteenth-century "re-discovery" of Angkor by Europeans, who became alarmed at the deteriorated condition of the monuments, the Ecole Française d'Extrême-Orient (EFEO) began work in the area in the early 1900s. For the next 70 years, EFEO conducted comprehensive documentation and restoration projects on most of the principal monuments, and vastly expanded international knowledge of Cambodia's rich cultural heritage.

An Angkor Archaeological Park was established in 1925 as the first national park in Southeast Asia. The Angkor Conservation Office, established in 1907, was supported for many years by EFEO and undertook the conservation and restoration of the major temple complexes until the early 1970s, when civil war forced the abandonment of all maintenance activities.

UNESCO's involvement

In recent years the inadequacy of the laws to protect cultural property and lack of a plan to control activities in the area has led to international concern for the protection of the outstanding heritage at Angkor. In 1989, the Supreme National Council in Cambodia asked UNESCO to coordinate international assistance to protect the monuments. Since that time a number of countries have supported a programme of assistance to safeguard and preserve sites at Angkor. An early task for UNESCO was to assist the authorities to draft cultural heritage protection legislation and statutes to establish a National Heritage Protection Authority. These were adopted in February 1993. Another task was to assist in presenting the sites for inscription on the World Heritage List.

World Heritage Status for Angkor

In 1991, Cambodia ratified the World Heritage Convention and in December 1992 the site of Angkor was submitted for inscription on the World Cultural Heritage List on the basis of the following criteria:

(i) it represents a unique artistic achievement, a masterpiece of creative genius;

(ii) it has exerted great influence over a span of time, within a cultural area of the world, on developments in architecture, monumental arts and landscaping;

(iii) it bears a unique, exceptional testimony to a civilization which has disappeared; and

(iv) it is an outstanding example of an architectural ensemble which illustrates a significant stage in history.

The World Heritage Committee agreed to the inscription although not all the usual requirements for listing were met. The Committee therefore made the listing conditional upon:

(i) the promulgation of adequate protective legislation;

(ii) the establishment of a national protection agency to coordinate site administration;

(iii) the demarcation of permanent boundaries;

(iv) the demarcation of buffer zones; and

(v) international monitoring and coordination.

THE ZEMP PROCESS

Angkor is an important national symbol of outstanding world significance. The area has vast tourist potential. The conservation and development of the heritage sites needs to be integrated into the national and local economy to bring benefits to the people of the region and as a contribution to rehabilitation of the country. The Zoning and Environmental Management Plan (ZEMP) is part of this process.

The project provides the Cambodian authorities with recommendations on the integration of arrangements for the protection of heritage with socio-economic development in the region. The aim is to propose guidelines for policies and zones to manage archaeological sites and natural areas, ensure balanced development of tourism and encourage ecologically sustainable agriculture and forestry activities. ZEMP also explored the legal and regulatory frameworks required to implement the guidelines and to ensure protection of the archaeology and tourist attractions of the area.

The ZEMP process was funded by UNDP and the Swedish International Development Agency (SIDA), with technical assistance contributions in kind from the Angkor Foundation of Hungary, the International Union for the Conservation of Nature and Natural Resources (IUCN), EFEO, United States National Park Service, and the Thai Fine Arts Department. The project was executed by UNESCO on behalf of the Ministry of Culture.

ZEMP brought together a multi-disciplinary team of more than 25 Cambodian and international experts in the fields of resource mapping, GIS and data management, prehistoric and Khmer history and archaeology, architectural conservation, hydrology, ecology and wildlife conservation, agronomy, forestry and rural development, social anthropology, tourism development, urban and transport planning, park planning and administration, and legal and regulatory frameworks for environmental protection and development.

Recognizing the need for analysis of a large amount of raw data which would be generated from the ZEMP sectoral studies, the project was designed using a GIS. The GIS allowed data from each expert to be cross-referenced in order to model different strategic options and to present the information in various form: as text, as statistics and charts, or spatially as maps. Photographs, remotely-sensed and video images, plans and drawings are also part of the GIS, and can be retrieved together with text, statistics and maps.

The first step in the planning process was to compile all previously available information from EFEO and elsewhere, such as maps, site reports, plans of the monuments, census data, etc., and enter this data into the GIS system. New information was added from satellite and recent aerial photography, which both corrected and substantially extended the previous data. By this process a **study area** was established, which covered approximately 5 000 km^2. This area has the highest known density of important archaeological sites. It also features substantial areas of critical ecological habitats and a variety of human uses of the land.

The ZEMP planning process was built on the corpus of known information about Angkor and previous zoning studies (Ministry of Education, Culture and Public Works, 1970; State of Cambodia, 1991, 1992) to incorporate the latest thinking on the planning and management of national parks and protected areas (IUCN 1986; WTO-UNEP, 1992; FNNPE, 1993; Lucas, 1993) and international guidelines on the planning and management of World Cultural Heritage Sites (Feilden and Jokilehto, 1993). The object was to produce a comprehensive zoning plan for the Angkor area.

From December 1992 to April 1993, most ZEMP experts made two visits to the site. The first was to survey the existing data, interpret aerial photographic cover and report on the status and potential of the area, providing data in a suitable form for digitizing into the GIS. The second visit was to participate in a three-week workshop to review and analyse the data in individual expert reports, previous regulations (State of Cambodia, 1992; Supreme National Council, 1993a, 1993b). The resulting policies, zones and guidelines are a synthesis of that analysis.

The final plan, to be published in the summer of 1994, is a synthesis of the analysis and follows extensive discussion with the government. Recommendations are made for geographical zones to protect important archaeological sites, to manage ecological areas and to identify areas for urban conservation and new development, particularly for tourism, and to delimit permanent boundaries for the Angkor World Cultural Heritage Site. The system of zones would be given a sound legal and regulatory basis and the impacts of development would be monitored using the Angkor-GIS established by ZEMP.

Major planning issues

In the planning and management of the material heritage of Angkor, three demands need to be reconciled: (i) cultural conservation; (ii) tourism; and (iii) productive use of rural resources. These three concerns must be balanced and tensions between them resolved through the planning and management process.

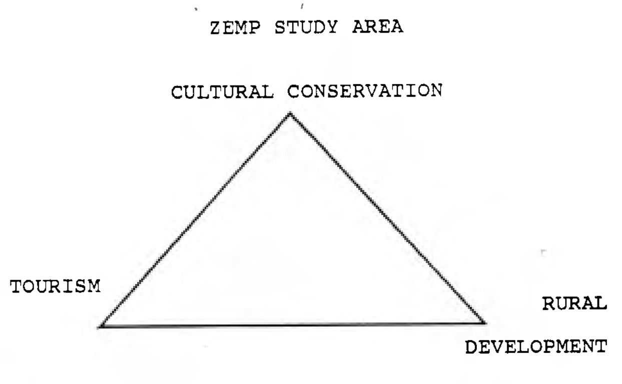


Figure 1.

The three pressures on the environment are represented in Figure 1 by a triangle within the ZEMP study area. The resolution of tensions between cultural conservation, tourism demands and rural development are assisted by the following: preparation of a zoning plan, policies and guidelines; establishment of a management authority with powers of decision and resources to implement them; and projects and programmes to promote sustainable forms of development.

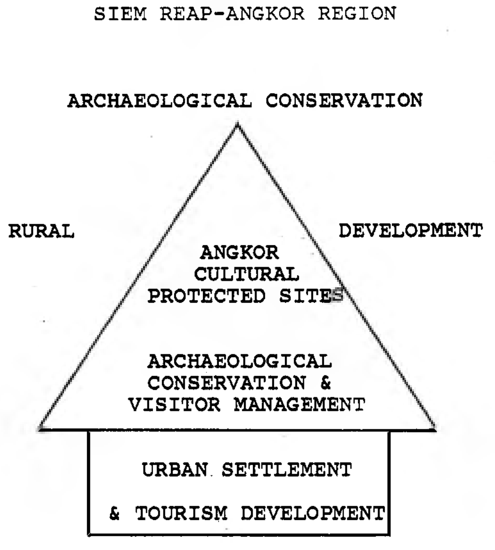


Figure 2.

Figure 2 is a spatial representation of the resolution of these demands. Within a zone called the Siem Reap-Angkor Region (SR-AR) a Protected Cultural Zone (recommended as the World Cultural Heritage Site) is proposed. Conservation of ecological areas, other archaeological sites and areas for rural development will be promoted in the SR-AR. This area also acts as the support zone to protect the World Cultural Heritage Site. Settlement and infrastructure development will also be encouraged outside the Protected Cultural Zone, subject to measures to mitigate damage to archaeology and the environment. The aim is to balance the interests of tourism development and protection of the archaeology of Angkor with the socio-economic needs of the Cambodian people.

The town of Siem Reap (population 45 000) is subject to pressure for urban expansion, improved infrastructure and investment in tourism. Siem Reap is the traditional "gateway" centre for tourists visiting Angkor. New tourist investment should be concentrated in the town, which has many attractive features.

Sustainable development

A number of guiding principles for development in the Angkor region were proposed and are being adopted. These reflect principles of sustainable development (IUCN-UNEP-WWF, 1991; Tourism Concern, 1992; IIED, 1993). In summary, they are:

1. Development should not degrade the resource base upon which it depends.
2. Cultural, ecological and economic diversity should be maximized.
3. Archaeological and environmental conservation can be tools to stimulate economic development.
4. Development activities should be based on local value systems.
5. Short-term benefits should not take precedence over long-term costs.
6. Economic benefits should be equitably distributed among the local population.
7. Development should be undertaken within a legal regulatory framework.
8. Developers should pay for all costs of negative impacts.
9. Zoning is a tool to achieve resource compatibility.
10. Sustainable development is a process; so plan as you proceed within a strategic framework and vision.

With proper controls, considerable economic development around the Angkor area can take place without endangering the monuments or underground archaeological sites, and should therefore be encouraged. For the foreseeable future, it is anticipated that tourism will form the principal economic base of the Siem Reap town economy. Elsewhere, exploitation of forests, minerals and other natural resources will provide another source of income, but these resources risk depletion. Cultural tourism should assume a larger and larger role as a major sustainable basis for provincial and, indeed, national economic growth.

ZONES, POLICIES AND GUIDELINES

A strong body of theory and practice has evolved relating to the definition, delimitation and management of protection and conservation of sensitive cultural and natural areas. A key principle is the protection of the most vulnerable areas by a managed buffer zone. Adequate control is achieved only when the buffer or "support zone" is under the full management control of the protected area authority. Therefore the core zone and the support (buffer) zone should be managed as a integral unit.

A zone may contain within it sub-zones, and zones may be sub-zones of a larger zone. For example, the Angkor protection and development zones are sub-zones of SR-AR. A protected zone that requires intensive site management should not be made too large because: (i) large areas require more financial and staffing resources to manage, and these will be in short supply for the foreseeable future; and (ii) strict regulations and management control over large areas will affect the interests of more residents and thus make enforcement problematic.

As part of the process to identify management zones for Angkor, the government has developed ideas for a *National System for Protected Cultural Sites*. The system comprises four categories of site, as listed below:

A NATIONAL SYSTEM OF PROTECTED CULTURAL SITES FOR CAMBODIA

Protected Archaeological Reserves

These are areas rich in archaeological remains which should be protected from damaging land use practices and intrusive development. They will often surround Monumental Sites and provide protection to adjacent areas of known or likely archaeological importance, much of which may not be obviously visible above ground. This category will be used to protect buffer zones around Monumental Sites.

Monumental Sites

These are areas which contain the most significant archaeological sites in the country and, therefore, deserve the highest level of protection. They may be quite small areas, but in the case of Angkor, rather large areas will be managed under this category because of the significance of the monuments and density of archaeological remains and the need to manage integral areas for visiting.

Sites of Archaeological, Anthropological or Historic Interest

These are all other important archaeological sites, but of less significance than Monumental Sites, that require to be safeguarded for research, education and/or recreation interest. Archaeological sites are generally small and free standing. The sites and areas will be subject to regulations to control damaging activities. These regulations will be similar to those applying in the Protected Archaeological Reserves.

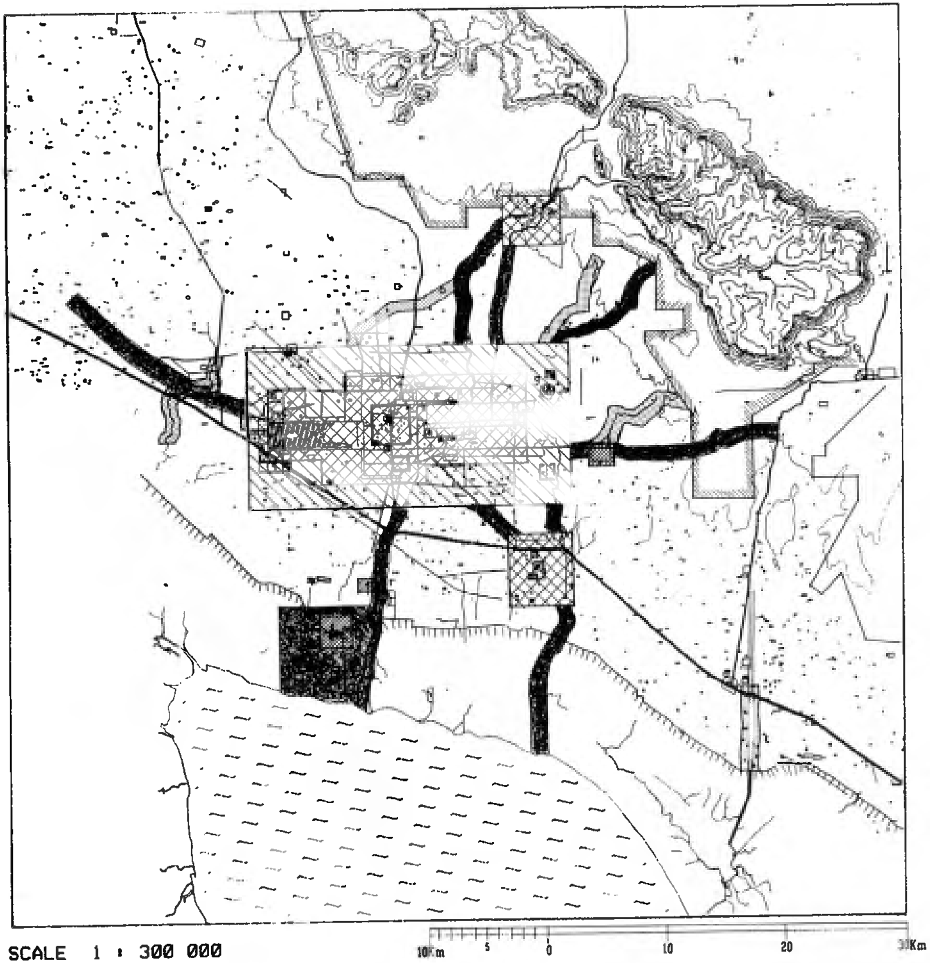
Protected Cultural Landscapes

These are areas with distinctive landscape characteristics which are protected on account of their traditional features, land use practices, diverse habitat, historic buildings and man-made features, deriving from the past or of more recent origin, and that contribute to cultural value and reflect traditional life styles and patterns of land use. Cultural landscapes may also safeguard views and relationships between significant features which contribute to their historic or aesthetic value. Protected Cultural Landscapes will be subject to regulations to control damaging and disruptive activities.

Defining zones

On the basis of the sustainable development principles outlined above, the proposed categories of national protected cultural sites and the information generated by ZEMP, provisional boundaries for archaeological protection zones were determined. The largest zone is SR-AR. This is the whole of Siem Reap Province and would be managed for multiple-usage, with an emphasis on socio-economic and cultural development.

PLAN 1



PROPOSED ZONES IN THE SIEM REAP-ANGKOR REGION

ZONING AND ENVIRONMENTAL MANAGEMENT PLAN FOR THE ANGKOR REGION

LEGEND

Protected Cultural Sites

- Protected Archaeological Reserves
- Monumental Sites
- Sites of Archaeological, Anthropological or Historic Interest

- Protected Cultural Landscapes

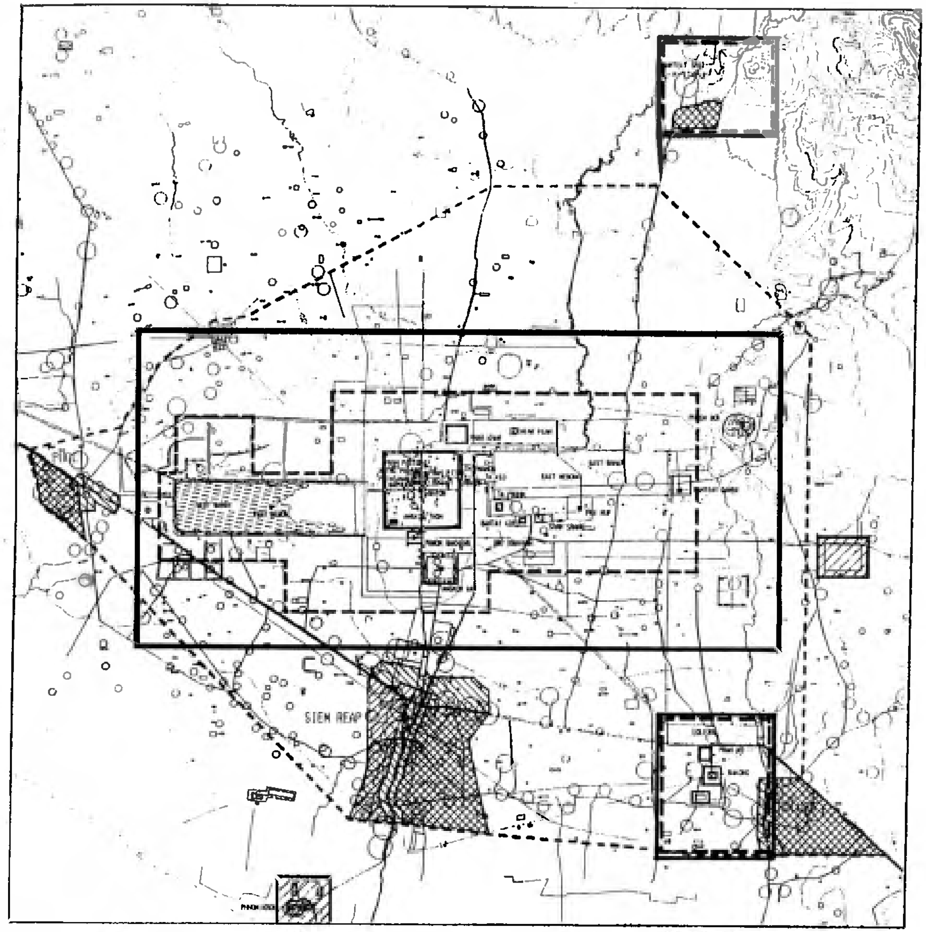
Ecologically Sensitive Areas

- River Corridors
- Tonle Sap Protection Zone
- Forest Management Zone

- ARCHAEOLOGICAL STUDY AREA BOUNDARY
- ARCHAEOLOGICAL SITES
- CONTOURS, 50 M
- PERMANENT STREAMS, BARAYS, MOATS
- NATIONAL ROAD
- PROVINCIAL ROADS

MINISTRY OF CULTURE UNESCO. © ANGKOR GIS. 1994.

PLAN 2



PROPOSED ZONES IN THE SIEM REAP-ANGKOR REGION

ZONING AND ENVIRONMENTAL MANAGEMENT PLAN FOR THE ANGKOR REGION

LEGEND

Protected Cultural Sites

- Protected Archaeological Reserves
- Monumental Sites
- Sites of Archaeological, Anthropological or Historic Interest

Urban Development Zones

- Urban Conservation zones
- Urban Expansion Zones
- Tourist Development Zones
- Proposed Road Corridors

MINISTRY OF CULTURE-UNESCO. © ANGKOR GIS. 1994.

Guidelines will apply for archaeological protection, sustainable use of natural resources and tourist development. Within this zone, specific conservation zones are proposed. These are shown on Plan 1, and consist of three Protected Archaeological Reserves (Angkor, Roluos and Banteay Srei), each containing inner zones designated as Monumental Sites and with maximum protection. These zones provide for the intensive management of many of the most significant archaeological sites that are also of great interest to visitors.

Protected Cultural Landscape zones are defined along significant causeways and canalized rivers, and extend the areas of protected Angkor heritage into the surrounding landscape. In addition, a number of Sites of Archaeological, Anthropological and Historic Interest are identified, and others may be proposed in the future. Ecologically Sensitive Areas have also been defined. These consist of the more important ecosystems in the study area. There are three zones: selected river corridors, the Tonle Sap wetlands, and the primary forest areas found mainly in the mountains.

Urban conservation and new urban development areas and a tourism development zone are also proposed, see Plan 2. The remaining parts of SR-AR are appropriate for sustainable forms of rural development. The delimitation of the zones attempts to balance the need for protection of cultural heritage and natural resources, with those of increased tourism and economic development within the province.

One of the purposes of ZEMP was to recommend boundaries for the Angkor World Cultural Heritage Site. It is recommended that the boundary should include the whole area under protection as an Archaeological Reserve (which includes Monumental Sites) and the areas designated as Protected Cultural Landscapes. This is an area of more than 300 km^2.

Regulatory guidelines are proposed for each zone. Implementation will depend upon the government developing new institutions to administer and enforce the zoning regulations. Intensive management for protection and visitors is necessary, particularly in the areas delimited as the World Cultural Heritage Site. However, even here, the management of archaeology and the management of visitors must be integrated with the interests of local residents, who will continue to live in some areas of the protected sites.

Rural development guidelines

The Angkor region contains extensive areas of valuable ecosystems which provide important habitats for wildlife. Regionally significant habitats, such as Tonle Sap wetlands, river corridors and forest areas, should be safeguarded and zoned accordingly. Because many environments result from past and present use of the land by man, their continued use by present generations should respect the historic values underlying the pattern of land use and indigenous vegetation. This will help to maintain biodiversity and protect culturally significant landscapes.

Many people in the region depend for their livelihood upon agriculture, fisheries and forest products. The local indigenous population is very poor and is growing rapidly. Consequently the environment is suffering from overexploitation. The sustainable use and management of the resources upon which these activities are based is vital to the welfare of the inhabitants. Pressure to utilize land more intensively is adding to the already existing problem of population and settlement inside and around heritage sites. Control over environmentally damaging practices, such as clear felling of forests, removal of natural habitat and pollution of water bodies, and safeguarding rare and endangered species, are necessary to avoid loss of natural and cultural assets upon which the region's long-term prosperity depends.

A policy of planned rural development should focus on increasing the availability of irrigation water to improve food security and to create alternative employment and settlement outside the main archaeological sites. The management of water resources in the mountains and rivers and in Tonle Sap could supply increased agricultural use and urban development; additional storage capacity however, is required to maintain minimum dry season flows in the rivers and to supply the ancient moats and barays as a tourist attraction.

Guidelines for the protection of archaeological areas

Safeguarding the material artifacts of past civilizations, below as well as above ground, is the only way the unique genius of these cultures can be studied and appreciated. Using modern remote sensing technology and recent aerial photographs, ZEMP identified more than 1 000 archaeological sites within the Angkor Plain, more than half of which were previously unrecorded, and more are waiting to be discovered. These sites now need to be described and defined by ground survey. The most important sites should be designated and protected as national cultural sites and managed as part of the national domain for scientific, educational and tourist purposes.

The seasonal flow of water was the lifeblood of the Angkor civilization. Remnants of the ancient systems of dams, dikes, canals, moats and reservoirs still regulate the supply of water for agriculture and irrigation to the present population. They are also an integral part of the archaeology and cultural heritage. The use and management of surface and underground water should take into account the need to conserve archaeological features and particularly ancient hydrological features. Where water is part of an archaeological site, it should be managed to preserve the archaeological values and historical authenticity of the site. Restoring and re-creating some of these ancient hydrological features can reconcile the needs of development with those of archaeological research, and enhance the tourist interest.

Given the development pressures facing the Angkor region, it is extremely important that a detailed knowledge of the archaeology is available. ZEMP experts recommend that all development projects should be required to include an archaeological survey of the area likely to be important, and that mitigation measures should be taken to safeguard the archaeological heritage to be affected.

A number of foreign institutions are interested in undertaking archaeological excavations and restorations. Procedures to manage and control these activities are urgently needed. A code of operation should be established and until then an immediate moratorium on archaeological excavation and reconstruction is recommended. This will enable an Archaeological Service to be formed and a plan and guidelines for archaeological research and architectural conservation to be prepared. The plan should set out the conservation philosophy and the cultural resource management policies by which the archaeological sites are to be managed.

Two decades ago the Angkor Conservation Office employed over 1 000 people on maintenance and rehabilitation works. Villagers again desperately need to earn income from work on the maintenance of the monuments, and other preservation- and tourism-related activities. Employment opportunities should be created for residents of the World Cultural Heritage Site area to provide alternative sources of income and thus reduce pressure for more intense exploitation of agricultural and forest resources within the protected areas. Participation of local people in management will build respect and understanding of their environment and archaeological heritage. This should reduce illegal excavation and increase awareness of the need for protection of the whole cultural landscape. Only a handful of people who were involved in archaeological conservation at Angkor before the war are still available. A new team of archaeologists and skilled workmen has to be created and trained and international assistance should give training a high priority.

Tourism development guidelines

The Angkor area offers a unique cultural experience. Tourism development should be based on Khmer archaeological heritage by making the monuments selectively available to visitors. The main temples have a limited capacity to accommodate visitors and, because of their age and fragility, will require maintenance and care commensurate with the number of tourists visiting them. The carrying capacity of the World Cultural Heritage Site should be established and tourism development planned and controlled within these limits. Proper visitor services such as information and interpretive exhibits, guiding, transport and carefully located refreshment centres, can increase the capacity.

The presentation and marketing of "Angkor" should emphasize the special cultural experience of visiting the ancient monuments, and discourage expectations of Angkor as a popular tourist entertainment destination. ZEMP considered that the least damaging tourism strategy and the one that could be most profitable, would be directed to attracting small numbers of high-paying visitors. Tourism policy should, firstly, develop the unique cultural experience of visiting Angkor and, secondly, maintain the small scale and friendly provincial character of Siem Reap as a tourist town.

Overcoming the lack of visitor facilities and tourism infrastructure will take a number of years. In the early years, the development of hotels should be slow and carefully regulated to minimize the negative physical and socio-cultural impacts of rapid development. An early task is to improve circulation and visitor facilities at the monuments, and establish an effective management regime for the World Cultural Heritage Site. A long-term management plan should be prepared for the protected cultural sites. Investment in tourism should be guided by a tourism strategy designed to attract high-quality private investment, and new development should be phased according to the capacity of the monumental sites to absorb visitors without damage or loss of attraction.

Luxury hotels, for which there is a demand, should be located where they can benefit from coordinated provision of services and where development can support desirable economic activity. ZEMP proposed a special tourism development zone in which high-quality infrastructure is provided and all major tourism investment concentrated. Design guidelines would reflect vernacular styles and encourage low density, low rise, timber and tile constructions, which involves a high input of local materials and local craft skills and therefore maximizes the benefits to the local economy.

Recommendations for an institutional framework for Angkor

There are many interests in the Angkor area. The aim is therefore to encourage coordination between the different interests and levels of government. Three levels of institutional building are identified:

1. the political level (making policy);
2. the technical level (making and enforcing regulations and guidelines); and
3. the operations level (implementation on the ground).

Executive responsibility for formulating and implementing policy requires professional and technical expertise, which could be made available through a special authority for Angkor, with strong links to government ministries. Enforcement of the regulations and management of the sites and monuments requires a strong presence in the region and on site.

The government is in the process of establishing an Angkor Authority, which would integrate policy and coordinate the work of central and provincial government and the special agencies operating in the Angkor area. The authority would develop and direct policy, monitor the impacts of decisions on the environment, co-ordinate and supervise the implementation of policy in the SR-AR and ensure day-to-day management of the protected sites. The authority would control the income and set the budget, and allocate funds to operational bodies.

The authority should have the following functions:

Management of the Angkor Sites: providing the policy context for management of the protected sites; approving site boundaries, site management plans and infrastructure development programmes (site transport systems, roads, visitor facilities) and supervising budgets.

Archaeological and Architectural Conservation: developing research in archaeology and conservation; establishing conservation priorities and developing techniques for the excavation, conservation and restoration of monuments and sites.

Environmental Management: close liaison with various ministries in the protection of the environment and the sustainable use of natural resources; establishing pollution control measures; preparing a water resources management plan for the

Angkor catchment area; and promoting forestry conservation and tree planting programmes.

Tourism: collaborating with the Ministry of Tourism in the preparation of a tourism development and marketing strategy (promotion of high-value, low-number cultural tourism, not mass tourism) and a phased investment programme; establishing a Tourism Development Corporation to facilitate timely development of hotels and facilities in Siem Reap.

Regional Development: coordinating the work of various ministries and agencies in the preparation of a regional development plan for SR-AR; transport infrastructure projects; and rural and community development programmes.

Urban Development: preparing an urban development plan for Siem Reap and assisting the provincial and municipal authorities establish development regulations.

Regulating Development: establishing guidelines and procedures to evaluate and approve projects and monitor the impacts of development on cultural and natural heritage throughout SR-AR.

Day-to-day management of the protected areas would be the responsibility of a re-invigorated Angkor Conservation Office. It will need to be expanded and strengthened to meet the challenges of maintaining the World Cultural Heritage Site. Duties could include:

- preparation of site management plans;
- site maintenance and site security;
- maintenance and restoration of the monuments;
- development and maintenance of site infrastructure and facilities;
- monitoring development impacts on cultural sites and advising on proposals affecting the sites;
- encouragement and regulation of development activities of local residents;
- visitor management and collection of entry fees;
- visitor safety;
- visitor information, interpretation and environmental awareness programmes;
- enhancement of the environment, woodland and landscape; and
- training in cultural resources and site management.

A Tourism Development Corporation for Siem Reap is suggested, which could plan and construct the infrastructure necessary to attract high-quality developments. It would be either a public corporation or a joint public-private organization, and would acquire land, plan and prepare serviced sites, and dispose of them by sale or lease to investors. Conditions would require the highest standards of development and operation to ensure the cultural authenticity and character of new development. Funds for developing and servicing sites could come from a partnership with investors, receipts from leases and sales, and loans raised against the value of the Corporation's assets.

LESSONS FROM ZEMP

The ZEMP study was carried out during a period of transition in Cambodia. Since the main ZEMP studies were completed, a new constitution is in place and a new Royal Government elected. The process to which ZEMP contributes is evolving and government policy is still being defined. Each contribution sharpens the focus and provides more detail for the management strategy and development of the organizational structures to protect Angkor. The government has accepted many of the ZEMP recommendations, but implementation has only just begun. Legislation to establish protection zones and an Angkor authority is currently in preparation (April 1994). A number of bilateral and multilateral funding agencies have already indicated support for major projects in rural development, transport studies, urban planning, tourism and the protection of monuments.

The Angkor monuments are part of an outstanding cultural landscape

ZEMP studies clearly demonstrated the extent and richness of the ancient Khmer cities and their hinterlands, which include not only the main archaeological monuments but also other man-made features, such as canalized rivers, dikes, reservoirs and flood control systems. The area between the Kulen watershed and the Tonle Sap lake is an ecotone in which the ancient inhabitants made maximum use of the wide variety of ecological niches and natural resources available, and they have left an outstanding legacy in the land. This forms a cultural landscape zone of great richness and one that should be recognized and protected as a whole, perhaps by listing Angkor under the new category of World Heritage Cultural Landscape Site.

Protected sites may contain people

Parts of Angkor have been continuously inhabited by villagers and farmers since the great cities were sacked and abandoned in the fifteenth century. Today, protected area managers recognize that traditional activities of indigenous people are part of the cultural resource and can help maintain and protect the landscape of a site. It is usually unnecessary and unrealistic to move established people from most types of protected area. However, it will normally be desirable to meet demand for new settlement, caused by the growth of population, in planned locations in the support zone adjacent to the protected area. At Angkor this could be achieved by selective rural and urban development programmes.

Integrated development

Because of their size, the management of the Angkor protected sites involves a number of different interests. The use of a GIS data base and an agreed zoning plan enables informed decisions to be made when facing a question of protection of the resource versus development for either tourism or to meet local need. Administrative structures need to ensure the coordination of functions and transparency in resolving conflicts. At the same time the political drive to get things done must not be lost.

Planning development pressures in areas well away from the sites to be protected requires a large planning area. Furthermore, a zoning plan needs to be based on simple concepts that are easily understood in order to influence policies. The ZEMP zones provide a framework for detailed planning and project implementation as new information becomes available and the technical capacity of organizations to plan and manage is improved.

Regulation of development

Until 1989 there was no private ownership of land; since then the move to allocate titles in land to occupiers has created a land market. However, the lack of land use development plans and regulations encourages unplanned construction in inappropriate locations, which is of long-term detriment to tourism. Legal frameworks for regulating development are an essential prerequisite to safeguarding heritage sites and implementing a zoning plan.

Matching resources with responsibilities

Managing the national heritage to attract international tourists to bring in foreign currency has a high priority in Cambodia. The management of the Angkor site as a visitor attraction must, however, have first call on the income generated. The management body needs a secure source of income from user fees which relate directly to its activities. In this way it is not dependent on annual allocations from over-stretched national budgets, which may lead to inadequate levels of funding for maintenance and investment.

The pricing of entry can often influence the level of use and be part of a strategy to keep numbers of visitors to within the capacity of the site. The ZEMP team considered that, given the low capacity of many of the monuments, a high entry fee would be appropriate and would not deter visitors sufficiently to cause a net reduction in income. This is because charges for entry are likely to be relatively small in comparison with the high cost of making a trip to Angkor. A policy of high entry fees may be more readily accepted by visitors if it is known that the income will be used for the conservation of the site. Taxes on tourists, not entry fees, are the main means of raising income for the national Treasury. However, the Angkor sites are not going to be self-sustaining for a number of years because of the enormous backlog of work to be done. International assistance will be necessary to achieve the level of protection and management desired.

The planning process

The ZEMP process itself was an ambitious undertaking. It had to reflect the absence of government policy on the management of cultural heritage and the lack of institutions to plan and regulate development. As the ZEMP team were expected to synthesize information from many disciplines, the project required an interactive method of working, and the whole team participated in the definition of zones and prescription of guidelines. It was unfortunate that, because of conditions in the country, the contribution of national counterparts was limited. However ZEMP's original recommendations have been developed in discussion with the new government since it took office, leading to an agreed framework for management.

Continued assistance to Angkor will be necessary because of the lack of trained or experienced professional and technical staff to rebuild institutions. An *International*

Coordinating Committee for the Safeguarding and Development of Angkor has been established to assist the government define priorities, prepare a programme of archaeological research and restoration and to ensure effective use of available international funds.

ZEMP demonstrates the importance of undertaking a comprehensive planning study of the whole area surrounding a World Cultural Heritage Site and establishing policies and zones, not only of the site, but also for the buffer and support zones around it. Of equal importance are adequate institutional arrangements to implement policy and enforce regulations so as to ensure the harmonious management of the site.

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THE TIME FACTOR ACCELERATING DETERIORATION AT THE GÖREME HISTORICAL SITE

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ABSTRACT

Close field observation carried out during the last decade has highlighted the significance of the time factor in accelerating the deterioration at the Göreme historical site. Natural processes continue to create new earth pillars and fairy chimneys, seemingly predestined for meditation. However, they can not remake the spiritual, artistic and intellectual elements that are such fascinating testimonies to the Byzantine Age. Cultural and natural structures are collapsing; decorative finishes are deteriorating; and both fauna and flora are becoming poorer at the Göreme historical site as time goes on.

The striking natural beauty and particularly the churches, monasteries, dwellings and associated structures are today at risk. This risk becomes increasingly serious with time. In order to counteract the negative consequences of natural events and mass tourism, effective engineering measures need to be implemented, following a review of research already conducted and after executing a detailed geotechnical investigation. Selection of proper engineering methods and measures is a subject of multidisciplinary coordinated work. Improving the environment, restoring and safeguarding are the closely interrelated tasks which have to be evaluated in both investigation and design phases. Grading of the land and creating a vast green space in the surrounding area by pumping water from the Kızılırmak River some 10 km to the north could control aeolian effects and thermoclastic processes, thus providing a long survival of hardpan (cap) and lichen cover. Reinforcement of the original entrances to the monuments, grouting, shotcreting [guniting], anchoring, sheltering, installing retaining walls and constructing more stable (reinforced concrete, stone, and/or stainless steel lattice type) access roads and sightseeing paths to provide easy access and close observation, are all of vital importance in lessening deterioration.

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Keywords

Structural conservation; ground levelling; green space; geotechnics; lichens; hardpan; qanat.

INTRODUCTION

The Göreme Historical National Park is a small part of the fascinating Cappadocia Region which covers a large area between the cities of Nevshehir, Nigde and Kayseri. Some of the well-known historical sites are Göreme, Zelve, Uçhisar, Ihlara Valley, Derinkuyu, Kaymaklı, and Soganlı (Figure 1). All are characterized by a striking natural beauty created by the extremely different mechanical and physical properties of the alternating layers of tuff, lapilli tuff, welded tuff, tuffite, agglomerate, and related lava flows (extrusive rocks). Those places are the sites of the most fascinating testimonies to the Byzantine Age.

Since the beginning of the century, numerous attempts have been made to save the masterpieces in the Cappadocia Region by national and international organizations, including the Turkish Government (General Directorate of Antiquities and Museums), UNESCO, ICCROM and UNDP. However, the historical places are still at risk and undermined, mainly by erosion and other negative effects of natural processes, coupled with mass tourism. Some of the churches mentioned by Guillaume de Jerphanion (1912) are no longer extant. Such extinction processes continue to increase the risk, particularly at the cultural structure sites.

The Göreme Historical National Park is distinguished by a high concentration of rock-hewn churches. The structural conservation of the site needs multidisciplinary work using an integrated approach. Much research and many investigations have already been carried out. However, a coherent geotechnical programme has not been implemented. In addition to a geotechnical investigation, the research already carried out, together with the studies in hydrology, hydrogeology (Yılmazer, 1986), general geology, topography, meteorology, and photogrammetrical documentation, can provide appreciable data on which to base an effective geotechnical design for preventing the continuing erosion and destruction of historical monuments as a result of natural and human factors.

The suggested geotechnical investigation programme would cover:

- a discontinuity survey on a 1:5 000 scale base map in the general surroundings, with a 1:100 scale base map over monuments and related structures;
- drilling where retaining walls and other engineering structures will be constructed;
- practical field and laboratory tests to establish engineering parameters; and
- investigation of the hydrogeological characteristics of the area by mapping seeps and springs and recording the stream discharge rates and groundwater fluctuation.

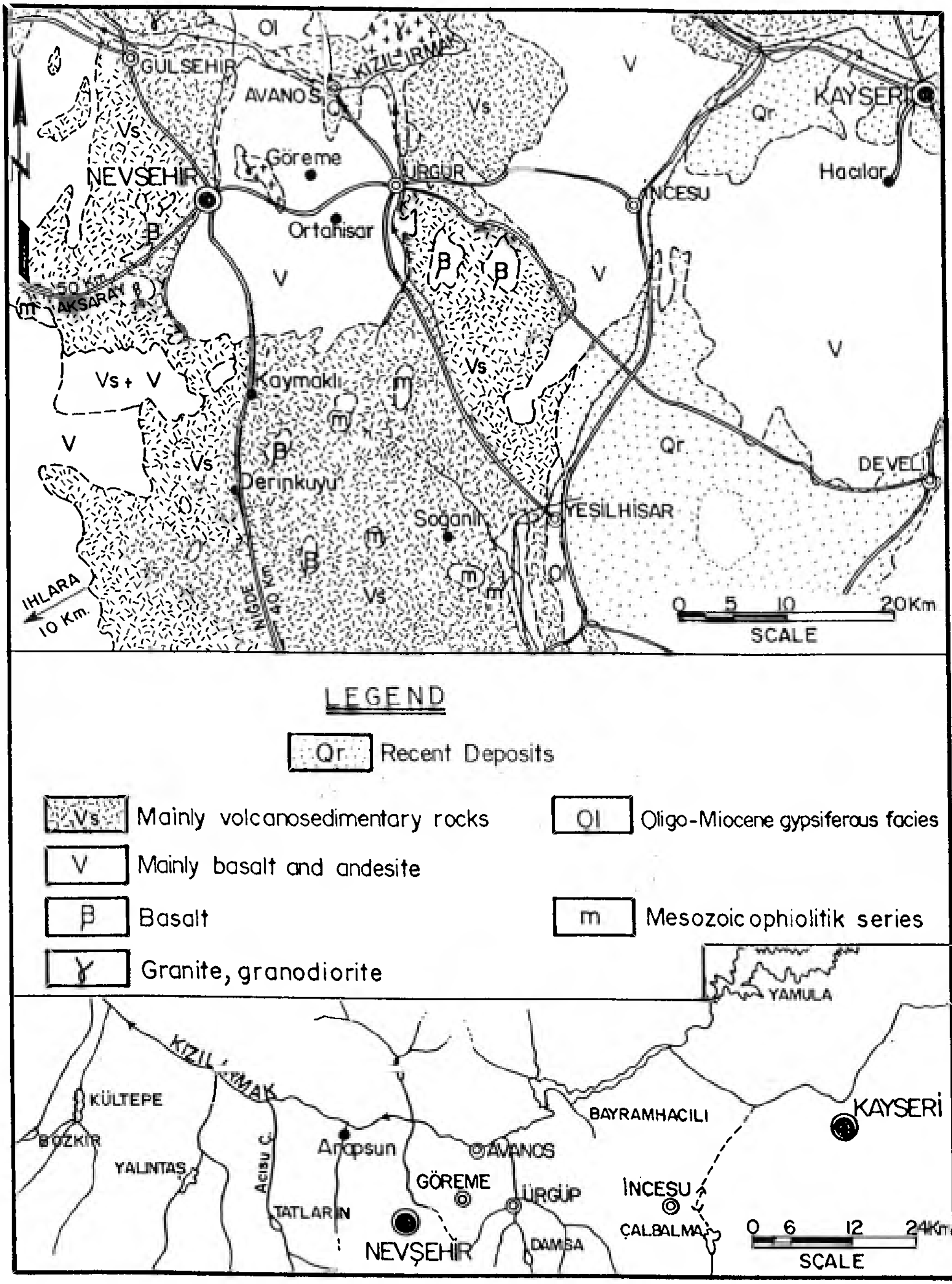

Figure 1. Simplified regional geological map (M.T.A., 1964) and Kızılırmak (Red River) with dams on itself and its tributaries.

GEOLOGY

The extensive Plio-Pleistocene volcano-sedimentary rocks constitute the essential part of the geological units. The alternating volcanic tuff, welded tuff (ignimbrite), lapilli tuff, and agglomerate horizons have differing engineering properties. Some of the layers are easily hewn and some are strong enough to support overburden stresses above ceilings (crowns). Layer thicknesses vary from a few centimetres to several metres. Pasquare (1968) has named the extensive volcanic rocks in the region of Nevshehir, Nigde and Kayseri as the Ürgüp formation, and he has distinguished 18 sub-units in this formation. Each unit has been described and mapped at a scale of 1:25 000. Doyuran (1976) has studied the environmental geology problems of Ortahisar, in the southern part of the Göreme-Ürgüp region. He prepared a 1:5 000 scale geological map of Ortahisar and its vicinity. Ash flow tuffs and pumice flows were found to be the dominant rock types.

The lava layers (mainly basalt) and volcano-sedimentary levels have erupted, then flowed and deposited in an aqueous (remnant of intercontinental sea) environment.

The left lateral strike slip fault, the Ecemis Fault, aligning from the Mediterranean Sea to the Kayseri region, the Tuzgölü Fault (Salt Lake Fault) defining the eastern coastline of the Salt lake, and oblique faults between these two major active faults, have created numerous eruption centres in the region of the cities Kayseri, Aksaray, Nigde and Nevshehir.

ENGINEERING GEOLOGY

The volcano-sedimentary unit comprises very weak to moderately strong tuff types, alternating with each other. Welded tuff and lava layers which crop out away from the Göreme Historical National Park site are, in general, moderately weak to strong rocks. The majority of volcano-sedimentary rocks cropping out in the area under consideration are very weak to weak. This is not due to weathering: it is a natural result of poor to very poor cementation. A barren surface (without hardpan or lichen cover) is fresh, but several times more erodible than a surface covered by hardpan or lichen.

The land, except the area adjacent to valleys, is barren or covered with very poor vegetation. Furthermore, alternation of layers with different colours made the discontinuities so distinct. Thus, their engineering properties could be evaluated relatively easily by a detailed surface inspection.

Bedding planes are tight, planar, and rough. Distinct fault zones are rare. Both fault zones, in general, have 10-50 cm infill. Joints are widely spaced, with an aperture width of a few centimetres at the surface and becoming closed with depth.

HYDROGEOLOGY

The Göreme area is drained by small streams which are ephemeral in character and they run into the Kizilirmak river some 10 km to the north. Güllü and Zemi are the two major creeks draining 1.5 km^2 and 8.5 km^2 areas respectively. Several *qanats* have been constructed to obtain domestic water. The one in the Güllü creek has collapsed partially. Nevertheless, it still provides clean groundwater at a discharge rate of 0.1 to 2 l/second. The sum of surface runoff and evaporation is much higher than infiltration. Sheetwash erosion is very effective, especially after a heavy rainfall over barren areas. The groundwater table becomes deeper than 25 m as one moves away from the valleys.

MAIN CAUSES OF DETERIORATION

Differential erosional properties of successive layers created distinct conical forms of the rock structures by the erosive action of basically aeolian and thermoclastic processes. The erosion processes will continue for ever, and new fairy chimneys and earth pillars will form. However, chapels and related cultural structures could never be reformed with their original identity. This is why they need very urgent reinforcement and safeguarding, as pointed out several times in the text.

Fine sand, silt and clay particles are easily taken into suspension. Due to the lack of vegetation cover and general weakness of volcanic tuffs, windblown particles make the aeolian processes more effective. Stress relief, created by erosion due to raindrops, sheet erosion and winds over the conical and dome-shaped structures, results in exfoliation and formation of thin layers, which are more susceptible to atmospheric effects. The jacking action of freezing water and the destructive effect of freeze-thaw cycling processes have produced infills, especially in joints and faults, creating significant reduction in shear strength of discontinuities.

Differential erosional property of successive tuff layers leads to undercutting of soft layers underlying a relatively stronger (competent) level. Collapsing, rockfalls, wedge failure and similar instability problems are accelerating. Unless the necessary engineering measures are implemented, these culturally important structures will continue to be at serious risk. Groundwater percolates through the permeable layers and/or discontinuities, and seeps out in and over impervious clayey tuff levels, thus predisposing towards unstable conditions.

Structural conservation engineers should make a great effort to recognize actual field evidence as well as laboratory test results. More than one hundred layers can exist in one geological unit, and each layer has different engineering properties. Moreover, lateral variation in one stratum is also considerable, depending upon the overburden, catchment area characteristics, geomorphological features, proximity to major fault zones, and other prevailing physical factors. Therefore, potential deterioration problems and proper solutions to them change markedly from place to place. All the papers about the Göreme region that the authors have read proposed that "the lichens are harmful and favour deterioration." The recently performed water repellent and consolidant treatment tests indicated that such treatments, not the lichens, increase deterioration. Test surfaces, covered with lichens which are 100 years old, were treated with water repellents six years ago (in 1987), stopping lichen growth. Large cracks have now formed and exfoliation has already started. Furthermore, a considerable body of field evidence is available which indicates that lichens to a significant degree prevent and/or reduce thermoclastic processes, eolian processes, raindrop impact and sheet erosion. Biologically, lichens could not deteriorate a one-centimetre-thick soil blanket during 300 years. Similarly, hardpan preserves surfaces from deterioration. A hardpan consists lithologically of salts and oxides which form a thin film on the land's surface. Tuff layers at the Göreme Historical site do not have mineral-type cement. They are grain-supported sedimentary rocks. A hardpan forms under the influence of capillary action and evaporation processes. It behaves like a mineral cement, forming a strong flexible cover which protects the surface appreciably.

Lack of reinforced sightseeing paths for visitors and uncontrolled, regrettable developments cause erosion by allowing destruction of the natural protection mentioned above.

CONCLUSION AND RECOMMENDATIONS

The Göreme Historical National Park is one of the most impressive historical sites in the Cappadocia Region. Almost all of the historical sites in this region have similar geological and geomorphological features, characterized by differential erosional property of alternating layers in the tuff-agglomerate succession. Hence, ground instability problems at these historical sites can be generalized as:

- sheetwash erosion;
- erosion due to aeolian processes;
- thermoclastic processes impeding the development of bark (hardpan) and lichen which protects the main body of structures from atmospheric processes;
- freeze-thaw cycling effects, especially in the surface without hardpan (i.e., exposed to climatic phenomena);
- jacking action of freezing water in discontinuities;
- undermining effect of groundwater over steep slopes and cliffs;
- erosion due to mass tourism;
- lack of support systems, especially in two-level or more hewn structures; and
- lack of designated proper access roads, sightseeing paths, and/or controlled observation locations.

In addition, some of the decision-makers do not like remedial work which may alter original natural appearance. These problems have been noticed and commented on by numerous investigators, and several alternative solutions have been proposed. Although deterioration and instabilities and their remedies are well known, no well-documented geotechnical design has been produced so far. A list of items to be taken into account when formulating an appropriate recommendation for a geotechnical design is given below:

- an effective irrigation system and accompanied levelling should be set up immediately to create a vast green space, to minimize erosion, and to promote faunal and floral diversity in the region;

- stimulate lichen growth and formation of hardpan in order to stop or minimize aeolian processes, the adverse effect of raindrop impacts, and sheetwash erosion. It should be kept in mind that tomorrow will be too late to commence the application phase of the structural conservation project;
- a detailed discontinuity survey should be carried out to define types of sealing agents and reinforcement;
- a 1:5 000 scale geological engineering map has to be prepared to provide an idea of the regional structural features. The results of previous *in situ* and laboratory tests will have to be reviewed so as to be able to define the engineering characteristics of the geological units;
- engineering and hydrogeological properties of discontinuities have to be mapped at a scale of 1:1 000 in the immediate surroundings to provide data for vicinity design work, and a 1:100 scale base map as for application design work, especially at the historical structural sites;
- undermining effect of groundwater over steep slopes and cliff should be minimized by installing horizontal slotted pipes along the intersection of major discontinuities and through the impervious clayey tuff layers. Grouting, wire mesh, fencing, levelling and shotcreting [guniting] might be implemented where needed; and
- no one person or institution has the right to prevent a visitor coming from great distances from entering an historic structure merely because its stability is in doubt. It should be possible to reinforce an unstable structure with the available technology and using practical engineering measures. Designated access roads, controlled sightseeing paths and observation locations, retaining walls, and pleasant surroundings have to be designed and installed as a matter of urgency. Such approaches and applications become less and less practical and more and more expensive with time.

Last but not least, it can be concluded that a considerable amount of research and investigation has been carried out. The basis is therefore available for engineering design to be started and detailed out under the supervision of engineers, city planners, architects and the other related disciplines who have been involved in similar application projects before. In order to galvanize activities for conservation projects in the Cappadocia Region, an independent agency should act on behalf of the Ministry of Culture and related international institutions, to coordinate designers, consultants, and contractors. Such an agency should be established and incorporated immediately. Otherwise, further decades will pass without any significant conservation works being implemented.

ACKNOWLEDGEMENTS

Individuals and organizations who sponsor and assist implementation of effective engineering measures to minimize deterioration at historical sites are deeply appreciated.

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EXAMINATION OF SURFACE DETERIORATION OF GÖREME TUFFS FOR THE PURPOSE OF CONSERVATION

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ABSTRACT

Extensive surface alterations of rock-cut churches, observed as colour change, biodeterioration crust, exfoliation and granular disintegration, have been examined from the surface to about ten centimetres depth. Investigations studied the mineralogical, petrographic, physical and mechanical properties and the durability of the tuff. Microclimatic characteristics of exposed rock surfaces were also determined over a limited period. These investigations used various analytical techniques, including optical and electron microscopy; X-ray powder diffraction analysis; spectrophotometric methods; pH, conductivity, temperature and humidity measurements; and some durability tests, e.g., wetting-drying, freeze-thaw and salt crystallization tests. The result have been interpreted in terms of the types of alteration, the depth of alteration, and possible methods of conservation. Further studies which will define proper conservation practice have been proposed.

Keywords

Tuff deterioration; tuff durability.

1. INTRODUCTION

The Göreme region of Cappadocia in Turkey has drastic deterioration problems. This work is only a part of the necessary structural conservation studies and it is only

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Figure 1. General view of St Barbara Church.

concerned with the deterioration problems of the exposed surfaces of the tuffs in the region (Caner *et al.*, 1987). Investigations were made of the types of alteration, depth of alteration, factors affecting alteration, assessment of the durability of tuff and on some microclimatic characteristics of the exposed rock surfaces.

As a pilot study, St Barbara church was chosen. Visible forms of surface alterations, as observed in the field, were yellow-pink coloration, mineral deposition, biodeterioration crust, exfoliation and granular disintegration (Figures 1 and 2).

There have been various studies of the geology of the area (Pasquare, 1968; Brinkmann, 1976: 71-78; Ilhan, 1976; Doyuran, 1976). The most extensive work has been carried out by Pasquare. He located rock-cut monuments in the Kavak member, which belongs to the lower levels of the Ürgüp formation. The Ürgüp formation lies horizontally and has a wide lateral extent. The Kavak member has some lithological variation in itself. Pasquare classified the Kavak member into six layers. Monuments in Göreme are located in two of these layers. The first one is a welded tuff, 30 m thick, and the second, overlying the first, is a lahar layer some 40 m thick.

Several reports have been prepared on the deterioration problems of the region (Torraca, 1972; Granier, 1976; Bowen, 1982; Lizzi, 1982). All of these reports are based on field observations. In addition, there are two important recent studies on mechanical and physical properties of tuffs in the Göreme valley (Erdogan, 1987), and its conservation by synthetic polymers used as water repellents and consolidants (De Witte, 1987).

2. EXPERIMENTS AND RESULTS

Experimental work consisted of several operations. Examination has been done of the stone surface up to 10 cm depth by mineralogical and petrographic analysis, elemental analysis, analysis of clay fraction, Ph measurement and soluble salts analysis. Physical and mechanical tests have been done to determine density, porosity and strength parameters, as well as tests to estimate durability (freeze-thaw, wetting-drying and salt crystallization tests). Finally, some microclimatic measurements were made to provide some indication of the likely impact of climatic conditions on the stone, such as temperature change at the surface and temperature change with depth.

Figure 2. A detail from St Barbara Church showing exfoliation and microbiological activity.

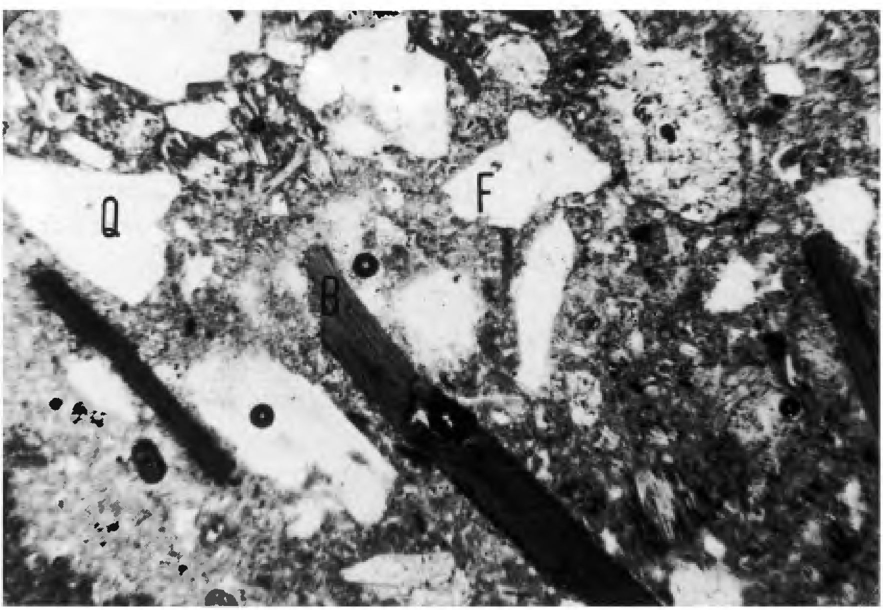

Figure 3. St Barbara tuff, showing quartz (Q), feldspar (F) and biotite (B) grains in clayey cement material. Cross nicols, 2.5 ×.

Figure 4. Extensively altered feldspar grain at 0-20 mm depth. Cross nicols, 10 ×.

2.1 Sampling

Samples were taken from the geological formation equivalent to that from which the St Barbara Church was hewn (Figure 1). In order to check for any changes in the tuff, samples were collected from different depths, starting with the surface.

2.2 Mineralogical and petrographic examinations

The volcanic tuffs under study mainly consist of plagioclase, quartz, biotite and opaque minerals as phenocrysts (Figure 3). In addition there are rock fragments of various kinds, pumice being the most common. The grain size in general is <1 mm. The cement material of these tuffs is smectite clay, identified by means of X-ray diffraction. Volcanic glass shards can be seen in the cementing material.

In the thin sections prepared from the uppermost 2 cm of the tuff, most of the feldspar grains are extensively altered (Figure 4). Alteration starts at the cleavage planes and its intensity is indicated by thick lines which correspond to decay zones. In a further stage of decay, fracturing and disintegration of the grains can be observed. The number of extensively altered grains decreases with depth. At a depth of 4-6 cm there is a clear decrease in the abundance of extensively altered feldspar grains, and fewer altered feldspar grains exhibiting thin lines of decay zones. At greater depths, lines corresponding to decay zones become thinner and most of the feldspar grains are unaltered (Figure 5). Gradual alteration with depth can also be observed in the biotite grains.

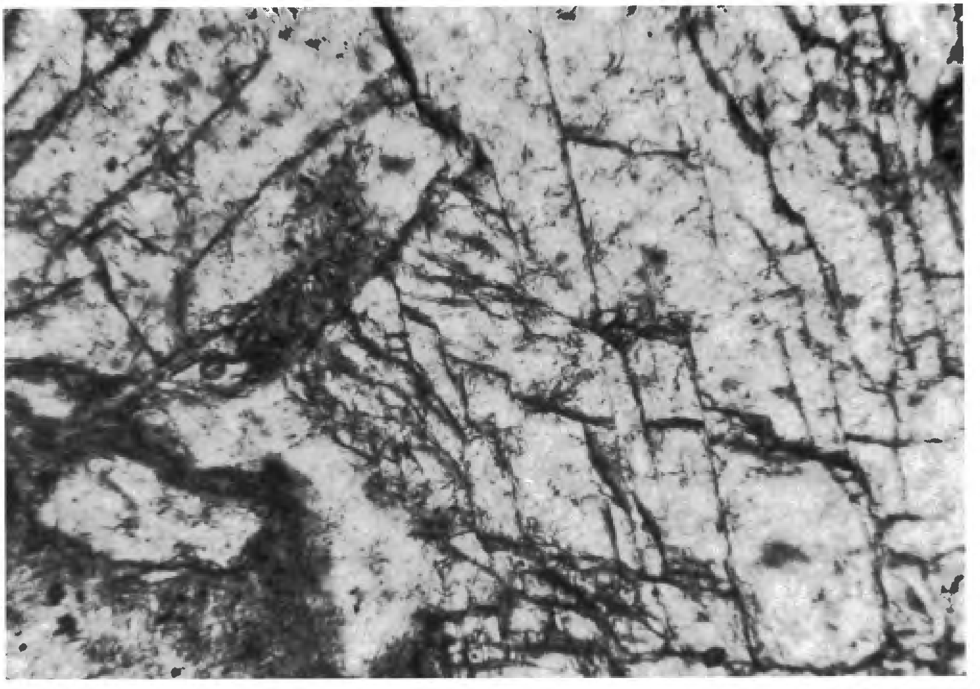

Figure 5. Non-altered feldspar grain at 8-10 cm depth, single nicol 10 ×.

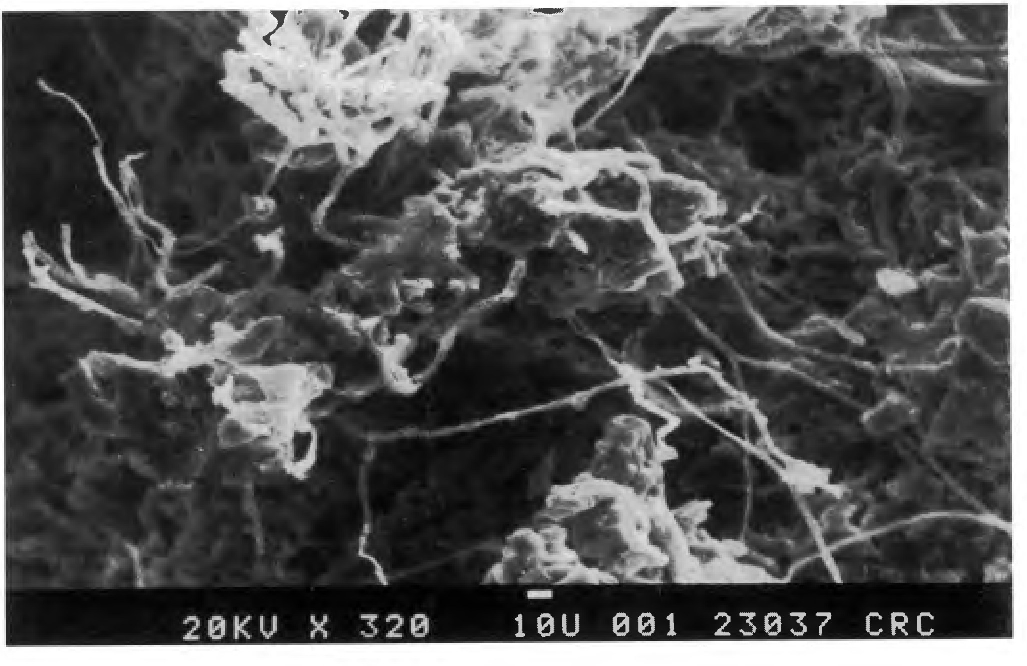

Figure 6. SEM photographs of tuff samples from the surface. Lichen hyphae penetrate into the structure.

Systematic rock samples (chips and cross-sections) have also been examined by scanning electron microscopy (SEM) for morphological properties and elemental compositions. Specimens were prepared using gold coating for morphological studies and carbon coating for elemental analysis and mapping. The instrument used was a LEITZ AMR 1000 microscope at 20 kV, coupled with an EDAX system.

The extent of alterations observed by this method supported the results of thin-section studies. At the surface, the contribution of lichens (microbiological activity) to drastic alteration of the tuff seems to be very important. Lichens establish themselves on the surface of the tuff (Figure 11) and initiate physical and chemical weathering. Optical and electron microscopy show that microfractures are produced, and changes in the composition of minerals and cementing material can occur.

In the field, surfaces of the tuffs covered with lichens show crust formation and exfoliation. Lichens penetrate well into the structure. Morphological studies by SEM demonstrate this very well (Figure 6). Abundant lichen hyphae or rhizinae can be seen at 1 cm depth, surrounding grains and spreading through the cement. Extensive alteration of feldspar grains can be seen at the surface layers, whereas fresh-looking grains are more common at deeper layers, about 10 cm depth (Figure 7).

2.3 Ph, soluble salts measurements and durability tests

For these measurements, tuff:water (1:5 ratio) extracts were prepared (Black, 1965).

Relative Ph values change slightly with depth, being about neutral at the surface covered with lichens, Ph 7.4, and becoming more basic at lower depths, Ph 8.4. The estimated total soluble salt content, which was calculated from electrical conductivity readings, was about 1 part per 1000 by weight, and showed a slight increase with depth. The soluble salts identified were mainly silicates, sulphates and chlorides of sodium, potassium, calcium and magnesium. The concentration of potassium ions was about four times higher at surfaces with extensive lichen growth, and decreased with depth. In contrast, the sodium ion concentration increased with depth (Caner *et al.,* 1987).

Durability tests show that this tuff is a poor quality building stone. Thus the fresh-looking tuffs from the pilot site had bulk density of 1.41 g/cm^3, compressive strength of 73.34 kg/cm^2, and effective porosity of 17.69%. It had good resistance to freeze-thaw cycling, some resistance to wetting-drying, but no resistance to salt crystallization, collapsing after only two cycles (Caner *et al.,* 1987; Erdogan, 1987).

2.4 Microclimatic measurements

Göreme valley has a continental climate. Summers are hot and dry, and winters are cold with moderate snowfalls that remain on the ground for long periods. Some severe frosts occur at this time. Springs are rainy. Average relative humidity is generally around 50%, being much higher in winter. Winds are mostly from the north and north-east.

Restricted studies have been made in order to get some information on the microclimate of the site. Some temperature and humidity measurements were taken at St Barbara church in May and December, 1986, representing two different seasons

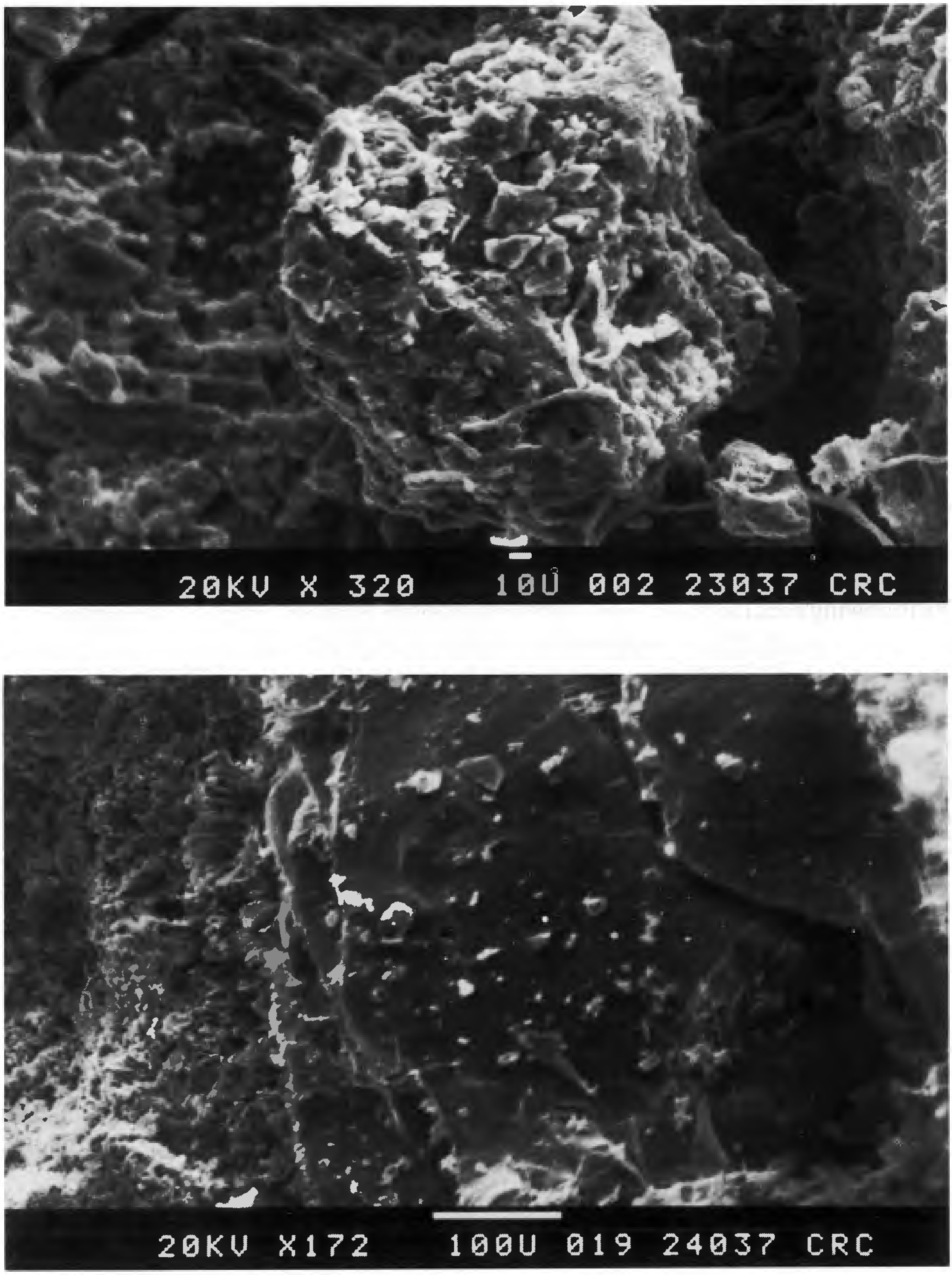

Figure 7. Feldspar grains. Above: extensively altered grain at 0.5 cm depth. Below: fresh-looking one at 10 cm depth.

(Caner *et al.*, 1987). During May, in a 24-hour period, maximum temperatures at some positions had reached 41°C, minimum temperatures being 9°C. Maximum temperature change for one point was found to be 28°C, whereas minimum change was 2°C. In December, in a 24-hour period, the maximum temperature observed was 23°C and the minimum temperature was around 1°C. Maximum temperature change for one point was found to be 21°C, whereas minimum change was 2°C.

Relative humidity values change drastically over a 24-hour period, both in May and December. The only difference is in the duration of high humidity conditions (exceeding 95% RH) which lasts for about 12 h in December and only about 2 h in May.

Change of temperature with depth from the surface of tuff was measured roughly by using a Lambrecht thermometer while slowly drilling a hole. The results show drastic changes within the rock at between 2 and 3 cm below the surface, with temperature decreasing with depth to about 6°C at 10 cm depth on a cold December day.

3. CONCLUSIONS

The following conclusions have been drawn regarding the conservation of the exposed surfaces of the tuff, based on the results of the pilot study area:

Depth of Alteration Exposed surfaces of the volcanic tuff undergo considerable change to at least 10 cm depth. Plagioclase feldspars could be used as indicators for the depth of alteration. Almost all feldspar grains were extensively altered within the outermost 3 cm, with the intensity of alteration gradually decreasing to a depth of around 6 cm. At about 10 cm depth, most of the feldspar grains were unaltered, although some extensively altered ones could still be found rarely. A small amount of kaolinite was detected at the surface, and is most likely the product of weathering of smectite and/or feldspar at the surface. Variations of soluble salt concentrations in the alteration zone should be related to mineral alterations, such as of feldspars, and ion-exchange capacity of smectite in the cement. Biotite grains can also be used as another indicator of alteration with depth, although they are less abundant than feldspar grains. Pink coloration of the tuff surface was due to iron oxide formation, most likely originating from biotite.

Important decay factors Wetting-drying and freeze-thaw cycles, biodeterioration crusting (mainly due to lichens), temperature changes, and soluble salt crystallization are the important decay factors.

Durability Durability of the tuff is poor.

Immediate studies needed Control of wetting and drying seems to be the most important conservation measure to control deterioration. Improvement of surface water drainage and use of portable cappings should be studied in this context. Proper water-repellent synthetic resins, and the use of protective sacrificial plasters and mortars may be other means of preventing the wetting of exposed surfaces. Selection and preparation of such materials should be based on thorough laboratory and field studies. The use of surface consolidants seems to be difficult, as deterioration is deep and drastic daily temperature changes occur, not only at the surface but to more than 10 cm depth.

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EFFECT OF DETERIORATION ON THE CHEMICAL AND PHYSICAL PROPERTIES OF GÖREME TUFFS

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ABSTRACT

The volcanic tuffs and unique morphological structures, the so-called "fairy chimneys," of the Göreme area have suffered chemical and physical deterioration due to atmospheric effects. Studies towards conservation of these valuable historical and touristic edifices should be based on an understanding of the processes which cause deterioration of the tuffs. In this study, the deterioration phenomena have been investigated using petrographical and geochemical methods. These involved thin-section studies, X-ray powder diffraction, and major and trace element analyses to determine the degree and depth of weathering. The effect of deterioration on the physical properties of the tuffs (unit weight, porosity and water absorption) has also been investigated. An attempt is made to correlate the chemical and physical parameters so as to understand the net effect of deterioration phenomena acting on the tuffs.

Keywords

Deterioration; geochemistry; physical properties; tuff; Göreme.

1. INTRODUCTION

The Cappadocia region is an important touristic site of Turkey. The region is very popular, with geomorphologically distinct features – the so-called "fairy chimneys" – and the relicts of ancient civilizations. The fairy chimneys have formed within the tuffs by the natural processes of weathering and differential erosion. The area within the Neveshir-Ürgüp-Avanos triangle is one of the well-known areas, where the fairy chimneys were hollowed to form dwellings and churches, and contain valuable wall

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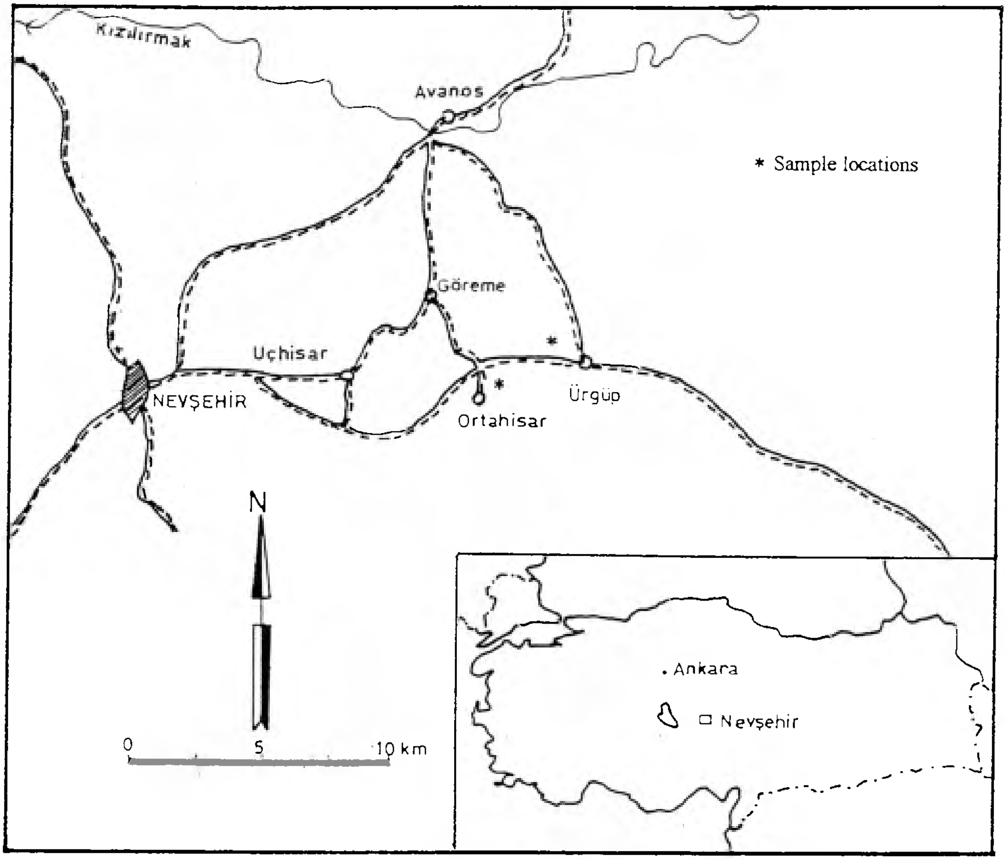

Figure 1. Location map of Nevshehir-Ürgüp-Avanos area.

paintings from the Byzantine period (Figure 1). Weathering and erosion, however, are still active and these natural processes, along with human activities, threaten the future of the chimneys. Although new fairy chimneys are being formed, the old ones need to be protected due to their historical heritage significance. Studies towards conservation of these historical and touristic values have already been started. Nevertheless, they should be based on an understanding of the processes which cause deterioration of the tuffs.

In this paper, the present state of weathering of the fairy chimneys within the aforementioned triangle is investigated. Emphasis is given to the change, if any, of chemical and physical properties of the tuffs with depth.

2. SITE GEOLOGY

The Cappadocia region is generally underlain by thick and extensive deposits of a volcano-sedimentary sequence (Miocene-Pliocene) of the Ürgüp Formation (Pasquare, 1968). Although the formation comprises a number of well-distinguished members, in the study area only the Kavak and Tahar members contain the fairy chimneys. Both members are characterized by non-welded tuffs. Due to the fact that most of the dwellings and wall paintings are found within the fairy chimneys of the Kavak member, our studies have focused on this member.

The Kavak member represents the product of the first intermittent volcanic activity which produced the Ürgüp Formation. Thus this member constitutes the basal portion of the volcano-sedimentary sequence. The chaotic arrangement of pumice fragments within the unit suggests that it is an ash flow tuff deposited in a lacustrine environment. It covers the existing paleotopography and shows laharic and/or tuffitic characters. It is dirty-white to pink, and contains phenocrysts of plagioclase, quartz, biotite and opaque minerals. Various rock fragments and pumice are also commonly observed. In the matrix, volcanic glass shards are rather common (METU, 1987; Türkmenoglu *et al.*, 1991). The Kavak member is about 120 m thick and dips 10 to 15° N and NE (Erdogan, 1986).

Some of the fairy chimneys formed within the Kavak member have a so-called "cap rock." Petrographical studies reveal that the cap rocks are made of welded tuffs (Topal and Doyuran, 1993).

3. METHODS OF INVESTIGATION

The fairy chimneys, which are partially covered by lichens and cut by joints, show clear effects of weathering, especially in the Göreme Open Air Museum. Since the weathering products are also protected in those places, field studies have concentrated on finding such typical locations in the study area in order to determine the state and depth of weathering.

Two block samples of the Kavak member were collected from two different locations. The Ortahisar sample had a lichen cover and the Ürgüp sample contained joints with intense discoloration (Figure 1). Since the depth of weathering in the tuffs of the Göreme Open Air Museum is found to be about 8 cm (Türkmenoglu *et al.*, 1991), the sizes of block samples were selected to fully incorporate the weathered zone.

For the petrographic studies, thin sections were systematically prepared from the two block samples to provide a continuous view of the tuffs from both lichen-covered and iron-stained surfaces to a depth of 23 cm. For the chemical analyses, 20 samples were obtained by scratching on the two block samples in the laboratory, from the surface to a depth of 23 cm. The scratched samples were then powdered to pass through 200 mesh.

Petrographic and mineralogical analyses were carried out using a polarizing optical microscope. Relative abundances of clay minerals was determined by X-ray powder diffraction (XRD) of the < 2 μm fractions. A total of 20 samples were investigated (10 unoriented powder samples from each block). The types of clay minerals, however, were determined by XRD on the same size samples as before, but on 5 oriented samples corresponding to each block (total 10 samples). The oriented samples were tested after air-drying, glycolation and heating. A RIGAKU diffractometer with CuKα radiation was used in the measurements. The measurements were performed at the General Directorate of Mineral Research and Exploration (MTA) in Turkey. Ten powdered samples from each block (total 20) corresponding to the same depth of samples used for XRD, were used for the major and trace element determinations by X-ray fluorescence (XRF). These analyses were carried out at the laboratory of Leeds University, UK.

For the determinations of physical properties, namely unit weight, porosity and water absorption, core samples of 25 mm diameter were recovered from the block samples. The tests were carried out according to ISRM (1981), RILEM (1980), and TSE 699 (1978) standard methods.

4. MINERALOGICAL PROPERTIES OF WEATHERED TUFF

Mineralogical and petrographical investigation of the tuff samples revealed that the samples consisted predominantly of quartz, plagioclase feldspar, biotite, and opaque minerals. Pumice was the most abundant one, and volcanic rock fragments (mostly andesite and basalt) could be easily identified both with the naked eye and under the microscope. The minerals and the rock fragments were embedded within a tuffaceous matrix composed of volcanic glass.

In the Ortahisar sample, extensive mechanical but very little chemical weathering of the minerals were observed within the upper 2 cm of the sample. Plagioclase feldspars were highly fractured at this zone. The cleavage planes of the feldspars and biotites were widened due to weathering. According to METU (1987), lichens play a very important role in deterioration of tuffs within this zone. Biotites and rock fragments, however, were slightly discoloured, with iron oxide staining at this depth. The effect of mechanical weathering decreased with depth and had almost ceased at a depth of 8 cm, whereas no chemical weathering could be observed after 2 cm depth.

In the Ürgüp sample, extensive mechanical and slight chemical weathering of the minerals were also noted within the first 2 cm of the sample adjoining a joint surface. In this zone, plagioclase feldspars were highly fractured and widened. Biotites were highly discoloured, resulting in iron oxide staining so that the outer boundary of the minerals could hardly be traced. In comparison, the rock fragments were slightly discoloured. The effect of mechanical weathering decreased with depth and had almost ceased at a depth of 10 cm, whereas chemical weathering – in the form of discoloration in biotites and rock fragments – extended laterally about 17 cm from the joint surface, but with decreasing intensity. In the field, however, a discoloured zone of up to 20 cm was observed.

In both samples the tuff matrix was partly altered to smectitic clay. The smectitic clay was not only found at the weathered zone but also away from it. So the alteration of volcanic glass to smectitic clay had probably started after the deposition of the tuffs and even before the formation of the fairy chimneys.

XRD analyses of 20 unoriented (powder) samples from the source of alteration to fresh parts in both Ortahisar and Ürgüp samples revealed that only very small amounts of clay minerals existed within the tuff samples, other than quartz, feldspar, and mica minerals. XRD analyses of the samples indicated no significant change in the clay content of the samples with depth. This conclusion is based on the presence of a very small peak area (also not changing with depth) of the clay minerals.

XRD analyses of 10 oriented samples after air-drying, glycolation, and heating at 300°C revealed mainly "smectite" types of clay mineral. A very small amount of mica (probably illite) was also observed. Since smectite is the major and the first formed clay mineral within the rock, this suggests that no considerable leaching processes had taken place within the system.

5. CHEMICAL PROPERTIES OF WEATHERED TUFF

Chemical weathering of rocks may result in changes in initial elemental concentrations due to leaching and enrichment (Borchardt, Harward and Knox, 1971; Borchardt and Harward, 1971). In order to determine the depth of chemical weathering, major and trace element concentrations – as percentages and ppm respectively – from the source of alteration (lichen and joint surface) at 10 different depths from each block sample (total 20 samples) were determined by means of XRF (Tables 1 to 4). Because chemical weathering is more pronounced nearer the source of alteration, much closer spaced samples were collected from the highly altered zone. The depths of samples, measured from the source of alteration, were 0-0.5 cm, 0.5-1 cm, 1-1.5 cm, 1.5-2 cm, 3-4 cm, 5-6 cm, 8-9 cm, 11-12 cm, 15-16 cm, and 22-23 cm.

Since the weathering products derived from the fresh tuffs were of major interest, analytical data were normalized by dividing each elemental composition of every sample by the same elemental composition of the fresh tuff sample. For this purpose, the Ortahisar sample obtained at a depth of 22-23 cm was considered to be a reference sample, and all the analyses at other depth intervals were normalized to that sample. This permitted easy comparison between the two different tuffs and between different weathering zones of each tuff. The relative contents (normalized values) of each major and trace element of both Ortahisar and Ürgüp samples are plotted against depth in Figures 2 to 7. Since the sampling points corresponded to a range of depths (e.g., 3-4 cm), an average depth was used for plotting the graphs. Considering that the weathering proceeds horizontally in the fairy chimneys, the depth of analysis of every element is shown as the abscissa of the graphs.

The relative content variations of major elements (oxides) of Ortahisar samples (solid lines) with depth indicate that significant enrichment of MgO, CaO, and P_2O_5 occurred within the upper 2 cm of the weathering zone, along with significant loss on ignition. The other elements do not change significantly (Figure 2). In the case of Ürgüp samples (dashed lines), however, a significant Fe_2O_3 and very little MgO enrichment was observed within the first 2 cm from the joint surface. Fe_2O_3 enrichment extends almost laterally to 17 cm depth (Figure 3). This depth is also determined from the discoloration of the sample observed in the field and under the microscope. Such reddish colour was attributed to Fe_2O_3 development. Similar reddish colour deteriorating the wall paintings also exists in the chapel at the north end of Elmali

Table 1. Major element analyses of Ortahisar samples

Depth (cm)	0-0.5	0.5-1	1-1.5	1.5-2	3-4	5-6	8-9	11-12	16-17	22-23
SiO_2	68.43	72.66	73.42	73.81	73.35	73.24	73.40	73.52	73.19	73.49
TiO_2	0.18	0.17	0.17	0.17	0.18	0.19	0.18	0.19	0.18	0.19
Al_2O_3	12.26	12.34	13.01	13.11	13.24	13.38	13.31	13.22	13.31	13.35
Fe_2O_3	1.30	1.16	1.12	1.14	1.15	1.14	1.11	1.17	1.15	1.16
MnO	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MgO	0.77	0.69	0.53	0.42	0.38	0.39	0.33	0.38	0.33	0.36
CaO	2.43	1.87	1.75	1.74	1.79	1.82	1.78	1.77	1.80	1.77
Na_2O	1.94	2.11	2.24	2.19	2.25	2.33	2.28	2.31	2.39	2.29
K_2O	3.51	3.64	3.83	3.90	3.95	3.93	3.93	3.98	3.94	3.88
P_2O_5	0.05	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.02
L.o.I.	9.48	5.15	4.10	3.99	4.05	3.93	3.59	3.52	3.81	3.57
Total	100.39	99.88	100.25	100.56	100.42	100.42	99.99	100.13	100.18	100.15

Table 2. Trace element analyses of Ortahisar samples

Depth (cm)	0-0.5	0.5-1	1-1.5	1.5-2	3-4	5-6	8-9	11-12	16-17	22-23
Sc	8	2	2	1	3	0	3	0	2	0
V	34	30	26	22	24	22	24	20	23	24
Cr	27	19	22	17	17	16	9	20	15	16
Co	9	9	7	9	11	17	8	7	4	8
Ni	9	6	4	3	5	6	3	4	4	5
Cu	7	7	12	12	16	26	9	18	4	11
Zn	37	30	33	32	31	31	32	36	31	32
Rb	123	133	137	135	140	137	141	139	139	139
Sr	225	236	231	221	225	229	223	219	234	224
Y	12	13	14	14	12	14	13	13	13	12
Zr	82	84	86	82	88	87	87	87	90	84
Nb	12	13	13	13	12	13	13	13	14	13
Ba	868	956	948	898	853	841	839	842	843	838
Pb	17	14	16	17	17	16	16	17	16	16
Th	21	23	23	23	24	23	22	23	23	21
U	3	4	5	4	5	5	5	5	5	5

Table 3. Major element analyses of Ürgüp samples

Depth (cm)	0-0.5	0.5-1	1-1.5	1.5-2	3-4	5-6	8-9	11-12	16-17	22-23
SiO_2	70.03	70.47	70.72	71.33	71.45	71.33	71.42	72.18	72.38	72.29
TiO_2	0.17	0.18	0.18	0.19	0.18	0.19	0.19	0.19	0.19	0.21
Al_2O_3	12.98	13.27	13.57	13.74	13.72	13.63	13.81	13.82	13.73	13.87
Fe_2O_3	4.98	4.20	3.10	2.89	2.78	2.36	1.68	1.74	1.57	1.44
MnO	0.05	0.05	0.06	0.06	0.07	0.10	0.09	0.08	0.12	0.06
MgO	0.52	0.45	0.46	0.40	0.40	0.40	0.40	0.40	0.38	0.42
CaO	2.01	1.96	1.96	1.95	1.93	1.87	1.88	1.83	1.84	1.87
Na_2O	2.18	2.13	2.58	2.27	2.34	2.38	2.31	2.33	2.35	2.44
K_2O	3.40	3.52	3.70	3.71	3.80	3.80	3.92	3.96	4.00	3.98
P_2O_5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02
L.o.I.	4.18	3.83	3.91	3.78	3.84	3.92	3.77	3.83	3.93	3.98
Total	100.53	100.08	100.27	100.33	100.53	99.99	99.50	100.38	100.53	100.57

Table 4. Trace element analyses of Ürgüp samples

Depth (cm)	0-0.5	0.5-1	1-1.5	1.5-2	3-4	5-6	8-9	11-12	16-17	22-23
Sc	0	0	0	0	0	1	2	2	2	1
V	26	23	18	18	17	25	21	21	15	21
Cr	16	20	22	21	11	10	15	13	19	17
Co	12	12	10	12	8	10	8	9	5	6
Ni	3	3	4	3	3	3	4	3	13	5
Cu	6	5	4	4	6	4	4	4	5	8
Zn	41	38	37	36	36	35	33	34	34	33
Rb	117	121	127	128	129	132	136	135	137	137
Sr	244	235	237	232	228	231	233	228	229	234
Y	11	9	9	11	11	12	11	12	11	11
Zr	81	81	88	88	88	89	93	86	91	89
Nb	12	14	13	14	14	14	14	15	14	14
Ba	856	810	818	819	853	911	905	894	979	864
Pb	21	18	17	18	18	19	19	17	20	19
Th	23	23	23	24	25	23	23	23	25	22
U	4	5	4	5	5	6	6	4	4	6

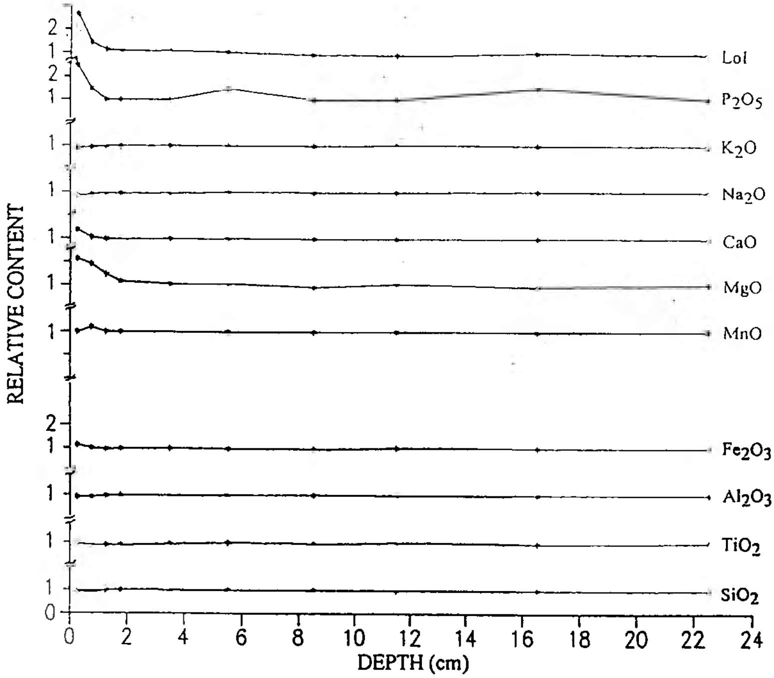

Figure 2. **Relative concentration variations of major elements in Ortahisar samples.**

church in Göreme Open Air Museum. MnO in these samples, however, fluctuated with depth.

Comparing both Ortahisar and Ürgüp samples, the Ortahisar sample had more enrichment in MgO, P_2O_3, and more loss on ignition, whereas the Ürgüp sample had more Fe_2O_3 enrichment (Figure 4). Excepting for the Fe_2O_3, all the variations within the samples were confined almost to the upper 2 cm of the weathering zones.

The relative content variations of trace elements of Ortahisar samples indicate that there was an enrichment of V, Ni and Zr, mostly within the upper 2 cm of the weathering zone (Figure 5). In the case of the Ürgüp samples, no significant change was observed. However, Ni shows fluctuations (Figure 6). In the graphs, Sc is not plotted because Sc was not found at a depth of 22-23 cm in the Ortahisar sample selected as the standard for normalization. Nevertheless, a close examination of the variations of Sc with depth in the Ortahisar sample (Table 2) clearly shows an enrichment within the uppermost 0.5 cm of the weathering zone.

A comparison of the relative content variation of trace elements in both samples reveals that only V, Ni and Zr of Ortahisar samples show variations (Figure 7). However, these variations are very small when compared with those of major elements. For this reason, major element analyses may be used to determine the depth of weathering of the tuffs. Evaluation of these analyses indicates that the depth of weathering in Ortahisar and Ürgüp tuffs is about 2 cm from the source of alteration. However, discoloration may extend laterally up to 17 cm in the case of Ürgüp tuffs.

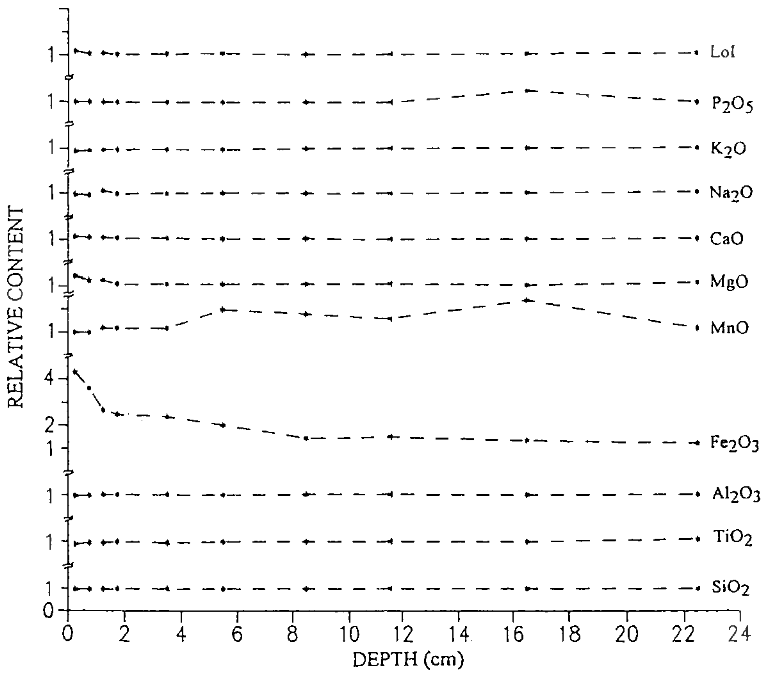

Figure 3. Relative concentration variations of major elements in Ürgüp samples.

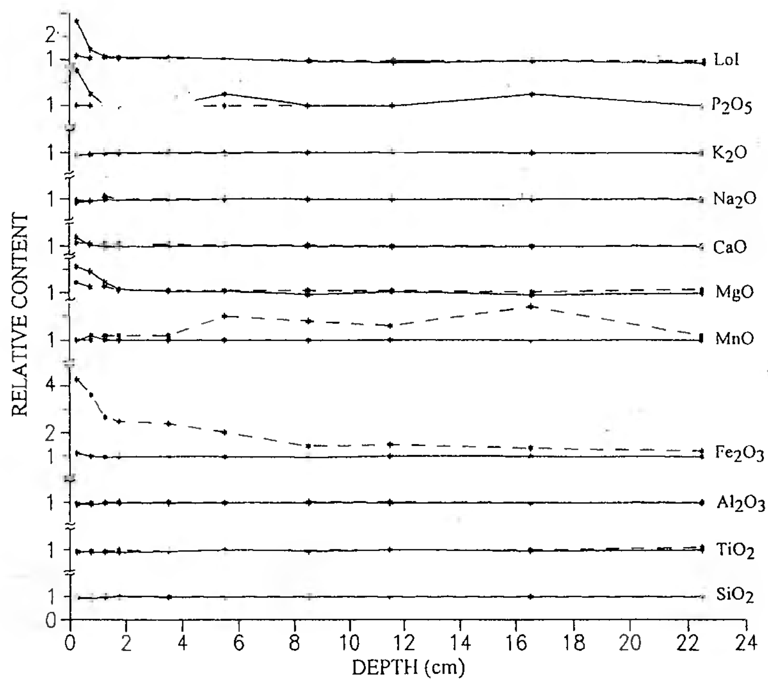

Figure 4. Comparison of major element concentrations of Ortahisar (solid lines) and Ürgüp (dashed lines) samples.

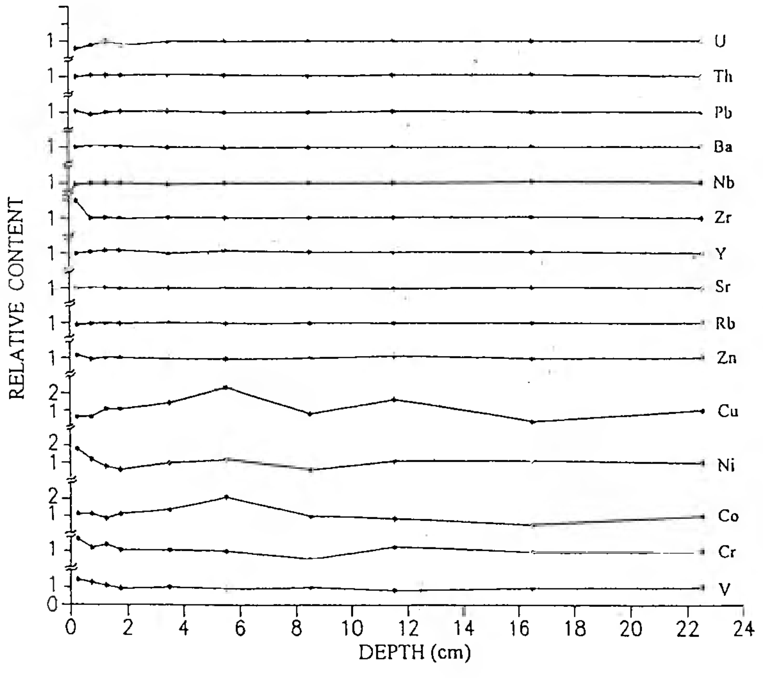

Figure 5. Relative concentration variations of trace elements in Ortahisar samples.

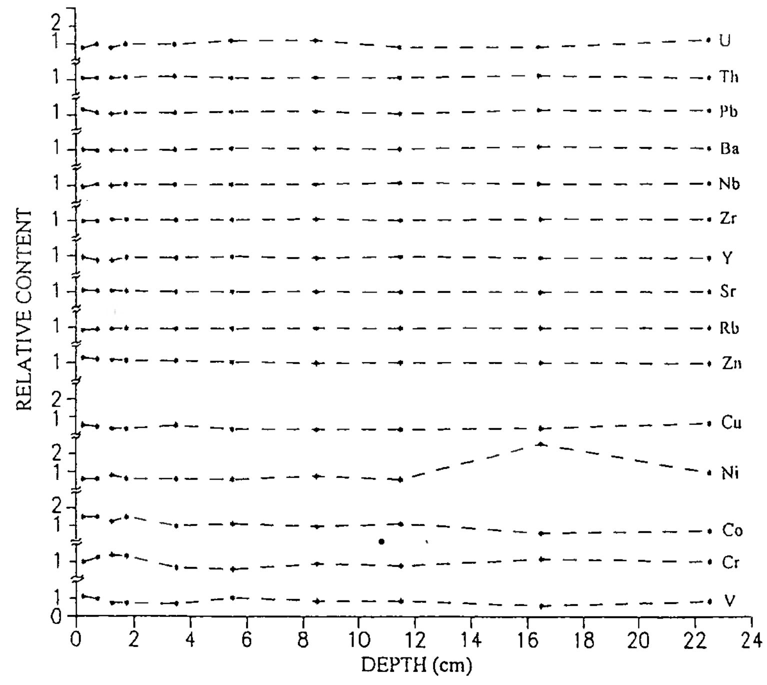

Figure 6. Relative concentration variations of trace elements in Ürgüp samples.

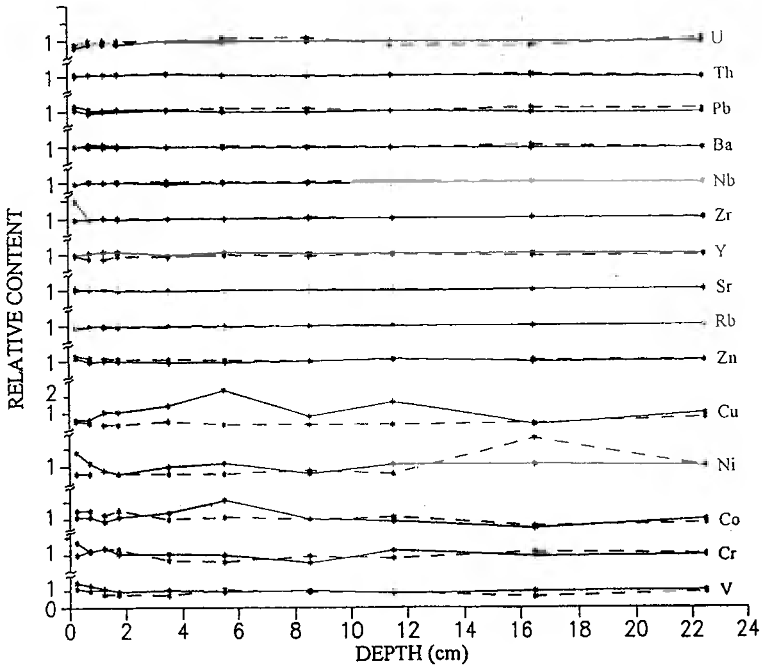

Figure 7. Comparison of trace element concentrations of Ortahisar (solid lines) and Ürgüp (dashed lines) samples.

6. PHYSICAL PROPERTIES OF WEATHERED TUFF

The effect of deterioration on the physical properties of tuffs was investigated by determining the variations of dry and saturated unit weight, effective porosity, and water absorption through weathering zones. Core samples of 25 mm diameter were extracted from the block samples and the tests performed at 4 different depths. The test results are given in Tables 5 and 6.

Based on the test results, no significant change in physical properties from source of alteration to fresh part of the tuffs was observed. Comparison of the test results between the two blocks also yields similar findings. Therefore, the effect of deterioration on the physical properties of the tuffs was not significant. Although the samples were taken from the area where the weathering products were well preserved, it is also possible that some portion of the weathered material might have been removed from the surfaces of the fairy chimneys.

7. CONCLUSIONS

The deterioration of Göreme tuffs produces chemically weathered zones restricted mainly to a depth of 2 cm adjoining the source of alteration (lichen or joint surfaces). The discoloration due to biotite and rock fragment alteration extends laterally up to a depth of 17 cm. Feldspars are mechanically weathered and the depth of weathering is

Table 5. Physical properties of Ortahisar samples

Depth (cm)	0-3	4-7	8-11	20-23
Dry Unit Weight, kN/m³	13.5	13.6	13.5	13.6
Sat. Unit Weight, kN/m³	17.6	17.6	17.6	17.6
Effective Porosity, %	41.1	40.8	40.8	40.5
Water Absoption (by weight), %	20.9	20.6	20.7	20.8

Table 6. Physical properties of Ürgüp samples

Depth (cm)	0-3	4-7	8-11	20-23
Dry Unit Weight, kN/m³	13.7	13.6	13.6	13.5
Sat. Unit Weight, kN/m³	17.6	17.6	17.6	17.5
Effective Porosity, %	39.9	39.9	39.9	40.1
Water Absorption (by weight), %	21.7	21.9	22.0	21.8

confined to the upper 8 cm of the tuffs. Volcanic glass is partially altered to form smectite. For the study of effect of weathering of Göreme tuffs, MgO, CaO, P_2O_5 and Fe_2O_3 as major elements, loss on ignition, and Sc, V, Ni and Zr as trace elements are the most significant parameters to determine the depth of weathering. However, major element variations are much more significant. Thus, investigation of the weathering phenomenon of tuffs should be based on the major element analyses.

An overall evaluation of the results of analyses reveals that chemical weathering is not very effective in the region. No significant change in the physical properties of the tuffs through weathering zones existed. Since the upper 2 cm of the tuff surface showed signs of alteration, this depth should be considered during conservation studies.

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CONSERVATION OF THE GÖREME ROCK

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ABSTRACT

The underground rock churches in the valley of Göreme, Turkey, are deteriorating seriously. This is caused, in major part, by the action of rainwater on the volcanic tuff.
Laboratory studies were carried out on freshly quarried tuff from the site to evaluate possible protective treatments. The results from artificial ageing of treated and untreated samples were examined by changes in physical parameters and scanning electron microscopy. Laboratory experiments were followed by experiments *in situ* on naturally weathered surfaces. After 5 years, control measurements showed that the results were at variance with those obtained in the laboratory.

1. INTRODUCTION

The Göreme Valley in central Turkey was intensively inhabited from the eighth to the twelfth centuries by Christian communities. Over the centuries, a complex rock-cut architecture developed which is still expanding. Many of the cavities have served as churches and were consequently decorated inside.

Due to stability problems, cracks appear in the domes of the structures and the resulting water infiltration increases their deterioration rate. Severe damage is especially caused to the wall paintings, which have been the focus of a restoration programme for the past two decades.

One of the main contributing factors to the overall deterioration of these structures is the water erosion of the external, exposed surface of the domes. A programme is currently underway to investigate the possibility of consolidating the rock to minimize this erosion problem.

At the request of ICCROM, our laboratory carried out an investigation to consolidate the rooftops of the Göreme rock churches.

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In a first phase, samples of volcanic tuff quarried in the Göreme valley were sent to our laboratory. Six commercially available products were tested for their effectiveness against erosion caused by the mechanical impact of rainwater. In a second phase, applications *in situ* were carried out, and after 5 years the effectiveness of this treatment was evaluated.

2. LABORATORY INVESTIGATION [1; 2]

2.1 Rock description

Samples of freshly quarried volcanic tuff from the Göreme valley were obtained for testing. The stone was analyzed petrographically and its physical characteristics determined.

2.1.1 Petrography

The sample of Göreme volcanic rock received for testing was a coarse-grained, poorly sorted, dacitic lapilli tuff in a glassy matrix. The lapilli (volcanic rock fragments 2 to 20 mm in diameter) were well rounded and consisted mainly of pumice with many vesicular cavities. In the fine-grained, largely glassy matrix, phenocrysts of little-altered feldspar (mostly plagioclase), quartz and biotite could be observed. There were a few small, opaque crystals (possibly magnetite). Clay minerals, formed by devitrification of the glassy material, were present and were analyzed by X-ray diffraction. They were found to consist of smectite (bidellite type), with only traces of mica.

2.1.2 Physical characteristics

The following physical characteristics were determined for the Göreme tuff, according to RILEM standard tests:

Porosity accessible to water	– RILEM test № I.1
Bulk and real density	– RILEM test № I.2
Saturation coefficient	– RILEM test № II.1
Water absorption coefficient (low pressure)	– RILEM test № II.4

The pulse velocity (km/sec) was measured with a Steinkamp ultrasonic tester. Each sample was measured in three directions, and in each direction three measurements were taken. The average value of all measurements was taken as the pulse velocity for the sample.

The capillary water absorption was measured by a test which differed from the RILEM test №II.6: after drying the samples at 60°C to constant weight, they were placed in a deep glass tray on a sheet of polyurethane foam with open cells. Water was then added to saturate the foam. At time intervals, initially very short, then longer, the samples were lightly wiped with a dampened shammy leather and quickly weighed, then replaced on the foam. The mass of absorbed water per unit absorbing area was plotted as a function of the square root of time. The capillary absorption coefficient was calculated from the slope of the plotted data.

The drying rate of the untreated samples was determined under two different conditions: at 60°C with no control of relative humidity, and at 20°C with 40% RH. In both cases the air velocity in the drying chamber was 2 m/sec. The samples were wetted by immersion for 24 hours in a tank filled with tap water. The samples were taken out, wiped lightly with a dampened shammy leather and wrapped with aluminium foil, leaving one side exposed. The samples were weighed initially and then placed in the chamber. At regular intervals they were taken out and weighed, replacing them each time in the chamber.

The difference in weight per unit of evaporating area was plotted as a function of the square root of time. The drying rate coefficient was calculated from the slope of the plotted data.

From the weight of the samples dried at 105°C, 60°C and at 20°C, the water retention could be calculated. Due to the high clay content in this tuff, the amount of retained water could be fairly large and would depend very much on the temperature. The data obtained from these tests are given in Table 1.

Table 1. Physical characteristics of the Göreme volcanic tuff

Porosity	42.3 %
Real density	2429 kg/m^3
Bulk density	1402 kg/m^3
Pulse velocity	2.058 km/sec
Saturation coefficient	64.2 %
Water Absorp. Coeff.(low pressure)	0.08 ml/min$^{0.5}$
Capillary Water Absorp. Coeff.	187 g/m^2.min$^{0.5}$
Drying rate @ 60°C @ 20°C	578 g/m^2.h$^{0.5}$ 444 g/m^2.h$^{0.5}$
Water retention @ 60°C @ 20°C	0.825 % 4.85 %

2.2 Products applied

The consolidants and water repellents used for testing were those which in previous studies had proved to give the best results. Commercial mixtures of consolidants and water repellents, such as *Wacker Stone Hardener H* (Wackerchemie) and *Tegovakon T* (Goldschmidt), proved in preliminary studies not to be as effective as successive treatments with a consolidant and a water repellent. Results for these two products are therefore not included in this report.

2.2.1 Consolidants

As consolidants, two products based on tetra-ethyl silicate were used: *Tegovakon V* (TEGV) (Goldschmidt) and *Wacker Stone Hardener OH* (WOH) (Wackerchemie). Both products are solutions of pre-condensed tetra-ethyl silicate in an organic solvent: TEGV in white spirit, and WOH in methyl ethyl ketone. Both contain 25% solvent.

2.2.2 Water Repellents

Two products based on oligomeric methyl siloxanes were used: *Tegosivin HL 100* (HL100) (Goldschmidt) and *Wacker 090* (W090). Both products are supplied by the manufacturer as concentrated solutions and have to be diluted before application. Both were diluted with white spirit to a concentration of 7% active ingredient. In the case of HL100, 2% of the catalyst *Tegosivin HLK* was added.

2.2.3 Capillary absorption

The capillary absorption coefficient for the consolidants and water repellents was determined by the same technique described previously for the capillary water absorption. The results obtained, all expressed in $g/m^2.min^{0.5}$, were: WOH= 302; TEGV= 250; W090= 296; and HL100= 195.

As can be seen, these products are absorbed faster than water, possibly because they are dissolved in organic solvents. The difference between the absorption rate for the consolidants can be explained by the nature of their solvents and the degree of pre-condensation. In the case of the water repellents, both diluted in the same solvent, the difference could be attributed to the different molecular weights of the siloxanes.

2.3 Application method

The impregnation of the samples was carried out by capillary absorption using the same technique described previously, but allowing the samples to absorb the products continuously, without intermediate weighing. From the weight difference between the untreated and the treated specimen, the consumption of product per unit absorbing surface area can be calculated.

After impregnation, the samples were stored for at least one month in a climate-controlled room at 20°C and 60% RH in order to allow all the solvents to evaporate and the products to react completely.

2.3.1 Consolidants

The consolidants were applied by either a single 10-minute absorption period, or in consecutive applications. In the latter case, up to four successive applications were carried out at 24-hour intervals. Care was taken that the total amount absorbed during these treatments should be comparable to the amount absorbed in the single 10-minute period. The consumption of consolidant per unit absorbing area is given in Table 2.

Table 2. Consolidant consumption (g/m²)

Treatment / Product	single treatment 10 min	consecutive treatments			
		1×	2×	3×	4×
WOH	727	354	524	619	682
TEGV	546	315	446	560	656

2.3.2 Water repellents

The water repellents were applied in two ways: in 1-minute absorption periods or 10-minute absorption periods. They were applied to both untreated and to previously consolidated specimens (single 10-minute treatment) 24 hours after applications of the consolidant. The average amount of water repellent retained per unit absorbing area is given in Table 3.

Table 3. Water repellent consumption (g/m²)

	Untreated samples		Consolidated samples	
Treatment time	1 min	10 min	1 min	10 min
Product				(Product)
W090	117	625	74	308 (WOH)
HL100	97	1451	74	577 (TEGV)

2.4 Testing of treated samples

All tests were carried out at least one month after the application of the products, in order to allow the solvents to evaporate and the active components to react completely.

2.4.1 Water absorption

Water absorption under low pressure was measured according to RILEM test Nº II.4. The measurements were followed for 24 hours to calculate the water absorption speed. The data are given in Table 4.

Table 4. Low pressure water absorption coefficient (WAC) and speed (WAS)

Product	WAC (ml/min$^{0.5}$)	WAS (ml/min$^{0.5}$)
WOH	0.08	0.097
TEGV	0.10	0.075
W090	0.01	0.010
HL100	0.02	0.011

As can be seen, a treatment with a consolidant hardly influences the water absorption capability of the stone, while the water repellent almost suppresses it.

2.4.2 Artificial ageing

All samples were subjected to artificial ageing in order to evaluate the effectiveness of the different treatments. The samples were dried to constant weight and then placed in the ageing chamber of a Weather-O-Matic apparatus. Further details of the physical disposition of this chamber are given in a previous report [2]. The artificial ageing process consisted of wet-dry cycling.

Each complete 4-hour cycle comprised:

- a 2-hour wet period, with constant UV light exposure (Philips HPK 125 W lamp) at 25°C, with eight rain shower events and four 5-minute heatings at 65°C (after every second wetting); and
- a 2-hour dry period with constant UV light exposure at 45°C.

Every 42 complete cycles the samples were removed from the ageing chamber, dried at 60°C to constant weight and weighed.

2.4.2.1 *Untreated samples*

These samples were subjected to rain showers with flow rates of 1.5 l/h or 0.85 l/h. The average weight loss was 4.45 $g/m^2.h$ at high flow rates, and 1.22 $g/m^2.h$ at low rates. The degradation process consists of the erosion of the glassy matrix, leaving the lapilli almost intact.

2.4.2.2 *Treated samples*

All assessments for these samples were carried out at the lower water flow (0.85 l/h) as the higher flow rate eroded the samples too much.

After the first 126 cycles, the samples were weighed every 42 cycles (dried at 60°C to constant weight). From cycle 337 onward the samples were aged only through wet cycles.

2.5 Visual observations

From visual observation of the exposed surfaces it was seen that those samples treated with a consolidant alone were less eroded than those treated with a water repellent, either alone or applied after consolidation.

It was also observed that samples treated by multiple applications were better protected than those treated in a single step, even though the total amount of consolidant absorbed in the stone was the same.

No significant differences were observed between the two brands of consolidants and water repellents tested.

The calculated weight loss showed very small differences between treated and untreated samples, which was not in agreement with the visual observations. This difference can be explained because, due to the experimental design, erosion at the back of the samples also occurred from rebounding water spray.

2.5.1 Scanning electron microscopy

Scanning electron microscopy (SEM) was carried out on specimens of the treated samples, before and after ageing. The specimens, taken from the exposed surface, were mounted on stubs and sputter coated with 10 nm of gold. No significant differences were observed between the two brands.

The water repellents, being pre-polymerized, tend to deposit a film over the particles in the stone as the solvent evaporates. The consolidants, on the other hand, seem to form a silica gel-type material.

2.6 Discussion

The results indicate that the degradation process of the Göreme volcanic tuff is based mainly on the mechanical action of water flowing over the rock, enhanced by the chemical weathering induced by the water in the glassy matrix. Similar deterioration mechanisms have been observed in other volcanic tuffs.

The treatment that protected the volcanic tuff better from erosion by a water spray was a consolidant one. That consecutive treatments protected the stone more than a single treatment could be explained by supposing that polymerizing tetra-ethyl silicate presumably bonds preferentially to other hydrolysing tetra-ethyl silicate molecules rather than to hydroxylated mineral surfaces. A deposit of silica gel-type material will only form a given number of bonds to the mineral surfaces, depending, among other factors, on the nature of the mineral in question. If several thin deposits are applied, it is conceivable that more bonds could be established with the surface of the minerals (no one deposition coats all surfaces completely) thus strengthening the bonding between consolidant and stone. The net effect in this case is an enhanced mechanical resistance of the consolidated stone. That a treatment involving a water repellent application on a consolidated stone should be less resistant than the consolidant alone can be explained as a function of the timing at which the water repellent is applied. In our laboratory experiments, the water repellent was applied after only 24 hours or a week of application of the consolidant. As the consolidant had not had time to react completely, preferential bonding could occur between the unreacted consolidant and the water repellent, reducing thus the number of possible bonds to the mineral surfaces.

Further studies are needed to understand the complex mechanisms operating in the matrix of a stone during the polymerization of tetra-ethyl silicates and the reaction of these with the siloxanes.

3. APPLICATION *IN SITU*

3.1 Introduction

The results of the artificial aging, described in Section 2, showed that the best protection could be expected from treating the surfaces with a product based on a solution of tetra-ethyl silicate. Confuting expectations, water repellents gave rather poor results.

In order to compare the results obtained in the laboratory with reality, field experiments were proposed. In our search for the necessary financial support, only the manufacturer of *Tegovakon V*, one of the products which gave satisfactory results in the laboratory tests, responded positively. Besides a grant to cover the travel expenses, they also offered to send the necessary products to Turkey at their expense.

3.2 Materials

On 12 May 1978, Messrs. Th. Goldschmidt, Germany, sent 1 barrel (190 kg) of *Tegovakon V* and 1 barrel (200 kg) of *Tegosivin HL100* to the General Directorate of Antiquities and Museums in Ankara. The General Directorate took care of the transport to the Göreme valley.

Although the results obtained with water repellents in the laboratory were rather disappointing, it was decided to execute a test in situ anyway.

The reason for this was threefold:

1) In a report made by a Middle East Technical University Research Team [3] it was suggested that a water repellent should give better results than a consolidant. These results were based on a petrographic analysis of naturally aged samples.
2) As all the laboratory tests were carried out on freshly quarried samples, it would be interesting to obtain as many results as possible on naturally aged material.
3) The application *in situ* of a second product would not increase the cost of the mission.

3.3 Selection of the test site

On arrival at the Göreme Open Air Museum, a test site was selected. After an inspection of the whole museum site, two areas were chosen between the Unnamed Church and Elmali. Both the slope of the surfaces and the exposure to weather conditions were very similar to the rooftops of the churches which urgently needed a protection treatment (i.e., Elmali church and the church of St Barbara). No tests were done on any rooftop itself, in order to avoid any interference with later treatments.

Because of the very high temperatures during the period of the mission (a heat wave caused midday temperatures of up to 43°C) it was decided to treat the two zones as follows:

- The first zone (hereafter called M-zone) would be treated in the morning, between 08:00 and 12:00. At that time of the day the zone was fully exposed to sunshine, although not yet completely warmed up. After the application of the products, the surfaces were exposed for the rest of the day to direct insolation.

- A second zone (hereafter called E-zone) would be treated at earliest 15 minutes after direct sunshine had disappeared. This meant after 18:00. In this way, the treated area would only be exposed to direct sunlight the day after the application of the products, which could react at lower temperature than in the M-zone.

3.4 Preparation of the test site

Before any intervention took place, each test zone was cleaned. By means of brushwood, all loose pebbles, sand and dust were removed. Lichens could not be removed in this way. After cleaning, 4 areas were marked on each test area by means of a metal pin. The sizes of these areas are given in Table 5.

Table 5. Areas of test zones (in m^2)

M - zone		E - zone	
A	1.549	U	1.492
B	1.565	V	1.892
C	2.467	W	1.811
D	2.527	X	2.144

Reference pins, 10 mm ∅ and 100 mm long, made of stainless steel and calibrated at 10 mm intervals, were placed in areas U, V, W and X. They were driven into the tuff with a hammer until the last but one mark was at the level of the rock. Between two pins the surface roughness was measured. This was done by tightening a rope from one pin to another and measuring the surface by means of a contour gauge.

By measuring these surfaces at regular intervals, for example every year, it will be possible to monitor erosion and to evaluate the effectiveness of the treatment.

3.5 Treatments

3.5.1 Test scheme

A plan was made to treat the different areas in each zone in the following way:

A and V: 3 consecutive applications with stone hardener, *Tegovakon V*.

B and U: 4 consecutive applications with stone hardener, *Tegovakon V*.

C and W: 3 consecutive applications with stone hardener, *Tegovakon V*, followed by 1 application of the water repellent, *Tegosivin HL 100*.

D and X: 1 application of the water repellent, *Tegosivin HL 100*.

A waiting period of 24 hours was respected between consecutive applications on the same surface.

3.5.2 Application procedure

All products were applied by means of a low pressure spray apparatus. In order to avoid any hazing of the products, the needle inside the spray nozzle was removed. In this way, a continuous flow of hardener or water repellent could be obtained. All applications were started at the upper right-hand corner of the area to be treated. The nozzle was then moved slowly from the right side to the left, taking care that the surface was completely wetted and that the product flowed down over 30 - 50 cm. Then the spray nozzle was moved to a lower part and the same operation repeated, till the whole surface was wetted. The treatment was stopped when the product, applied on the upper part of the treated zone, had flowed down over the whole area and reached the lowest part.

3.6 Consumption

Consumption was measured after each application. The results are shown in Table 6.

Table 6. Consumption of stone consolidant and water repellent in M- and E-zones

M-zone								
	A		B		C		D	
Treatment	time (min)	l/m^2	time (min)	l/m^2	time (min)	l/m2	time (min)	l/m^2
consolidant	15	1.807	15	1.656	20	1.487		
consolidant	6	0.903	5	0.662	11	1.045		
consolidant	8	0.645	4	0.397	8	0.562		
total consump.		2.355		2.715		3.094		
water repellent					5	0.400	26	2.148
E-zone								
	U		V		W		X	
Treatment	time (min)	l/m^2	time (min)	l/m^2	time (min)	l/m^2	time (min)	l/m^2
consolidant	13	2.680	16	2.377	11	1.656		
consolidant	5	0.670	13	1.056	8	0.878		
consolidant	6	0.402						
total consump.		3.752		3.433		2.534		
water repellent					7	0.496	6	1.165

3.7 Impregnation depth

In order to measure the impregnation depth of the products, without damaging the M- or E-zones, identical application was carried out on another zone, near to each of the two test areas. Two days after the application of the products, half of the small treated zone was removed with a chisel to a depth of several centimetres. By wetting the profile with small droplets of water, the impregnation depth could be assessed.

Depending on the composition of the rock, the impregnation depth was between 4 and 8 mm.

3.8 Discussion

3.8.1 Number of treatments

Despite the original plan being to consolidate surfaces A and U 3 times and B and V 4 times, the treatments on U and V were stopped after two and three treatments respectively. The reason for this was the rather low absorption after the third treatment and the effective hardening obtained after two days.

Three minutes after the third treatment was stopped, the whole surface was still very shiny, because the product stayed at the surface and did not penetrate. This shiny appearance lasted for at least 10 minutes.

In fact, at the bottom of area C after two days, the sand that fell down from the surface above during the preparatory cleaning was already consolidated by the runoff of excess liquid.

3.8.2 Consumption

From Table 6, it can be seen that the consumption of hardeners was much higher than what might have been expected from the laboratory tests. This was due to three reasons:

- In the laboratory, application was by capillary absorption, without any loss of product. During the *in situ* application, some product flowed down from the surface and was absorbed by the underlying sand. It was also impossible to limit the application exactly to the borders of the marked zone, thus the treated areas were in reality slightly higher than the marked ones.
- Due to the aging of the surfaces, these were very rough, in contrast to the samples received for the laboratory tests, which were freshly sawn.
- Two of the surfaces (C and D) were covered with lichens, which were not removed with the cleaning method used. The presence of the lichens obviously increased the consumption.

3.8.3 Hardening time

In the laboratory the hardening of tetra-ethyl silicate takes several days, sometimes up to weeks. A water repellent is effective after 1 week. The extreme high temperatures during the application period caused a considerable increase in reaction speed. As mentioned above, the stone hardener consolidated sand within only two days. One day after the application of a water repellent, this was already effective.

3.8.4 Colour changes

Consolidation

The application of *Tegovakon V* gives the tuff a wet appearance. This is supposed to disappear after complete hardening of the tetra-ethyl silicate. After the treatment a few rusty-coloured stains appeared. This was possibly due to the presence of compounds which react with the catalyst. The same effect has been noticed before when stones containing glauconite are treated. More research to explain this phenomenon is necessary.

At the border line between areas A and B, a narrow whitish strip appeared after some days. This seemed to have been almost pure tetra-ethyl silicate, hardened on the surface of the rock. Because of overlap of treatments on A and B, this area can be considered as having been treated 5 to 6 times. The tetra-ethyl silicate no longer penetrated the rock but polymerized at the surface. This indicates that, when treating, care has to be taken to avoid applying the tetra-ethyl silicate in excess.

Hydrofugation

The application of *Tegosivin HL 100* gives the tuff a pink appearance. The same reaction as the one that occurred with the consolidant is without any doubt responsible. The fact that the water repellent contains a higher concentration of catalyst could explain the more intense reaction. Although colour changes are in general unacceptable, it has to be remarked that in many places in Göreme and Zelve the natural colour of the tuff is pink. Thus, should the results of the treatment prove positive, we believe the colour change cannot be considered as a major counter-indication.

3.8.5 Influence of the treatments on water absorption

The areas treated with *Tegosivin HL 100* were already showing a distinct pearling effect 2 days after the treatment. These areas can be considered as completely impermeable to liquid water.

Areas treated with consolidant were still wetted, but without really absorbing large amounts of water.

3.8.6 Effectiveness

The effectiveness of the stone hardener could not be measured during this mission. This would have to be done in the future, by measuring the surface roughness of the treated and non-treated zones and comparing the results with the data given here.

The effectiveness of the *Tegosivin HL 100* as a water repellent was excellent, but as this treatment did not give good results in protecting the stone against erosion, time would have to decide.

4. EFFECTIVENESS AFTER 5 YEARS

Five years after the application *in situ*, an effectiveness check was carried out on the treatments. After a visual inspection, the surface roughness, using a tightened cord and a contour gauge, was measured in the same way as described before.

4.1 Visual inspection

The most striking feature was that the non-treated, control area as well as the areas which received only a consolidant treatment showed significant erosion. Surface measurements proved that between 10 and 22 mm had disappeared from those surfaces. No difference in erosion between consolidated and non-treated areas could be noticed. The areas treated with a water repellent, or with a combination of water repellent and consolidant, were damaged in two different ways. Primarily at the bottom, the treated areas showed thick flakes, which were either completely loose or could easily be removed by some mechanical action. On the higher parts of those areas, the surface showed a crazed pattern, but here the treated surface was still good, and adhering to the underlayer. However, it could be expected that this surface would also peel off with time. The pink colour, observed some days after the treatment with the water repellent, had almost completely disappeared. Only a few small protruding lapilli were still coloured.

4.2 SEM analysis

SEM of the consolidated areas showed no presence of the silica-gel-like material deriving from the consolidant. Analysis of flakes lifted from a surface treated with the water repellent showed that flakes of the polysiloxane were still present, but much smaller surfaces of the rock were covered.

4.3 Roughness measurements

Figure 1 shows the results of surface roughness measurements at 4 different places at the border of a non-treated area and an area treated with HL100.

Figure 2 shows the surface roughness measurements in a reference area and in areas X (treated with a water repellent) and U (consolidated).

4.4 Discussion

The results after 5 years show that the Göreme rock has eroded by 10 - 20 mm. The treatment with a consolidant based on tetra-ethyl silicate does not seem to have improved the resistance of the rock to weathering. Treating the surface with a siloxane stabilized the surfaces for several years, after which the impregnated layer started cracking and finally split off.

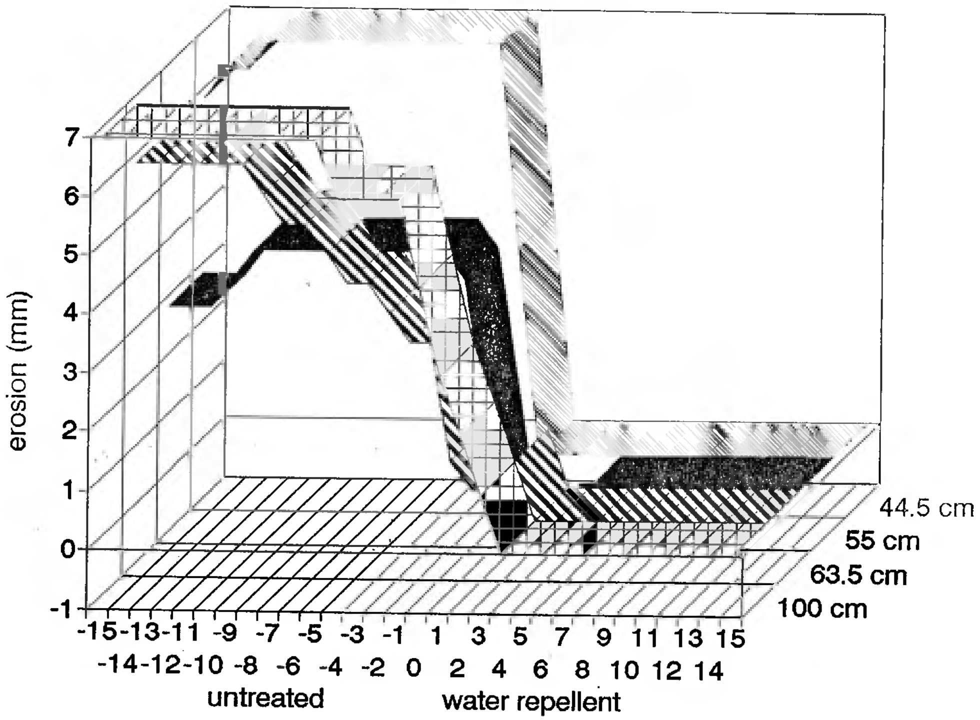

Figure 1. Surface roughness measurements at 4 different places.
Left: non-treated surface
Right: surface treated with a polysiloxane

5. CONCLUSIONS

From the experimental treatments on freshly quarried samples and artificial aging carried out in the laboratory, it was concluded that erosion of the Göreme volcanic tuff is mainly caused by the impact of rainwater and that this phenomenon could be slowed down by treating the surfaces of the stone with consolidants based on tetra-ethyl silicate. A treatment with a water repellent or with a combination of tetra-ethyl silicate and water repellent did not give satisfactory results.

In situ applications carried out on naturally weathered surfaces on two test zones in the Göreme Open Air Museum led to the conclusion that:

- Two or three applications, with an interval of 24 hours between each, saturate the surface. More applications could result in a whitening due to the formation of silicium dioxide at the surface.
- When treatments are executed during summer, it is advisable to apply the products after 18:00, in order to avoid extremely high polymerization speeds. It would be better to apply the products in a period when no temperatures higher than 30°C are expected.

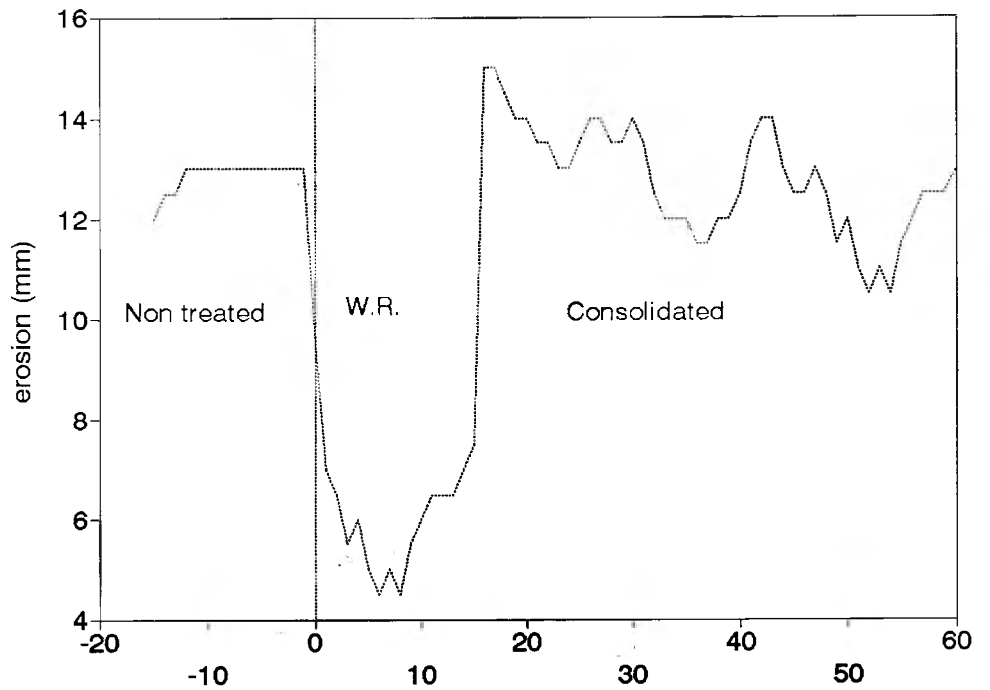

Figure 2. Surface roughness measurements 5 years after treatment.
Left: non-treated surface;
Middle: treated with a polysiloxane;
Right: consolidated.

- Although the colour changes obtained with the hardener and the water repellent are aesthetically acceptable, it would be worthwhile to investigate their origin.
- The consumption is, depending on the treatment, between 6 and 20 times higher than that measured in the laboratory on fresh samples.

Effectiveness measurements after 5 years of application *in situ* yield results contradictory to those expected from laboratory and initial *in situ* testing. Consolidated surfaces eroded at the same speed as the untreated control surfaces. Erosion was of the order of 2 - 5 mm/year. A treatment with a water repellent seems to protect the surface for several years, but long-term protection is not guaranteed. After only 5 years, the impregnated surface shows unacceptable cracking or even flaking.

The results of this research show that laboratory results cannot always be transposed to reality and that each laboratory investigation has to be confirmed by experiments *in situ*. Concerning the protection of the domes of the churches in Göreme, more research should be carried out before products based on tetra-ethyl silicate or siloxanes are applied.

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STABILITY ANALYSIS AND MONITORING OF ROCK-HEWN CHURCHES IN THE GÖREME VALLEY

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ABSTRACT

The paper describes the main types of damage observed in some rock-hewn churches (Elmalı, St Barbara, El Nazar, Meryemana) in the Göreme Valley (Cappadocia, Turkey). The damage is mainly due to instability problems with rock wedges and to the effect of water flow. The criteria for evaluating the instability conditions of the rock mass are presented, as well as the typologies of the consolidation techniques to be adopted. Special attention is also devoted to the problem of structural monitoring, which is a very reliable means of verifying the present static conditions of the churches. A simple monitoring system, installed in 1986 during the mission organized by ICCROM, is presented.

1. INTRODUCTION

Several rock-hewn churches in the Göreme Valley are affected by instability problems. These problems are very severe in the churches that are located near the rock slope, where large gaps can be seen in the joints caused by the loosening of the rock mass. In July 1986, the author was invited to take part in a mission organized by ICCROM to evaluate the structural condition of four rock-hewn churches in the Göreme Valley, namely Elmalı, St Barbara, El Nazar and Meryemana.

The most significant problems observed in the four churches are the result of instability phenomena of rock slabs or wedges (due to the rock mass loosening) and to the effects of water flow. In some churches, only small sized rock wedges are unstable (Elmalı and El Nazar); in other churches the instability phenomena involve large portions of the rock mass (Meryemana). The methodological approach proposed for the study of the static conditions of the rock mass around the churches is as follows:

- a geological survey and lithological description of the rock types;

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- a structural survey of the rock mass for careful description of discontinuities (joints or faults) which may affect the stability conditions of the rock mass itself;
- determination of the shape and size of the unstable rock wedges; and
- stability analysis and design of stabilization solutions.

Special attention must be devoted to the problem of water flow, which can induce a remarkable decrease in the shear strength along the discontinuities, and significantly erode the softer rock layers.

An important contribution to the knowledge of the stability conditions of the rock mass is given by the use of a monitoring system that measures the relative movements along the discontinuities and evaluates the evolution of the deformation processes as a function of time. The analysis of the velocity of these deformations makes it possible to foresee potential instability phenomena and to make prompt decisions concerning the work needed to stabilize the unstable rock wedges.

During the site visit in 1986, a simple monitoring system was installed on the main cracks of the four churches studied, using a simple, removable mechanical strain gauge. The monitoring system should now be improved and enlarged, and then extended to many other churches.

2. STRUCTURAL ANALYSIS OF THE ROCK-MASS AROUND THE CHURCHES

As mentioned above, a detailed description of the discontinuities of the rock-mass is a necessary step in any kind of stability analysis. The parameters selected to describe discontinuities are the following:

- orientation
- spacing
- areal extent
- roughness
- wall strength
- aperture
- filling material
- water flow

These parameters, which are essential for stability analysis, should be quantified whenever possible. The structural survey of the rock-mass makes it possible to define the shape and size of the potentially unstable rock wedges. The shear strength along the critical joints (potentially affected by sliding) are estimated with acceptable accuracy using the Joint Roughness Coefficient and the Joint Wall Compression Strength. For stability analysis, the limit equilibrium method can be used; this method is also capable of determining the external forces (magnitude and direction) required to increase the factor of safety to the desired value. The design criteria for reinforcement differ in relation to the size of the unstable rock wedge. In some churches the potentially unstable rock wedges are only a few metres thick, while in other churches thicknesses of 10 to 20 m have been observed.

2.1 Small, unstable rock wedges (Elmalı)

On the rear side of Elmalı church, two potentially unstable rock wedges have been noted (Figure 1). A first wedge (A), which rests on wedge B, shows clear signs of sliding movement and rotation, and seems to be very near to collapse (Figure 2). A second, larger wedge (B) is potentially unstable because of potential sliding along a joint surface which intersects the inner painted wall of the church.

In addition, the joint on which wedge B rests is also affected by water percolation, with two very negative results: a progressive decrease of the shear strength along the joint surface, and very dangerous consequences to the painted surfaces. The critical stability conditions of wedges A and B clearly indicate the need for urgent intervention. The stabilizing technique suggested for small wedges is based on the use of special rock bolts grouted into small diameter boreholes bored by means of a rotary drilling machine. Stainless steel reinforcing bars should be used or, alternatively, fibreglass or other materials which are corrosion resistant. For wedge A, passive rock bolts are suggested with a length of 2 to 4 m, while for wedge B the reinforcement should be longer (6 to 8 m) and the rock bolts could be tensioned to a low stress level. In the case of small wedges (such as wedge A), the application of concentrated forces should be avoided, given the poor mechanical characteristics of the material. The use of grouting in combination with rock bolts is necessary in the event that the aperture of the joint is significant. It should be noted that the use of short reinforcing bars could have prevented the recent collapse of small wedges from the vault of El Nazar church (Figure 3).

Figure 1. General view of the rear side of Elmalı church indicating potentially unstable rock wedges.

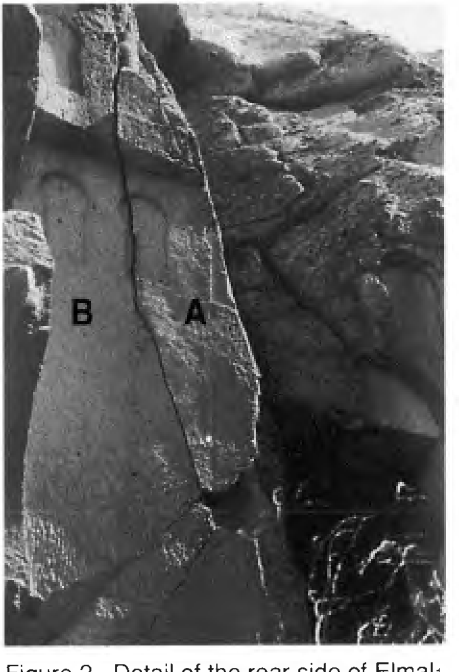

Figure 2. Detail of the rear side of Elmalı church showing the critical stability conditions of wedge A.

Figure 3. View of the vault of El Nazar where small rock wedges collapsed recently.

Figure 4. View of the church of Meryemana showing very large open cracks. The dangerous effect of water flow on the paintings can be clearly observed.

2.2 Large, unstable rock wedges (Meryemana)

The Meryemana church is located near the edge of a high, steep slope which is considerably fractured and loosened. The loosening has led to unstable conditions in large portions of the rock mass, causing very wide gaping at the joints. Figure 4 shows a view of the church, where large cracks can be seen a distance of about 8 to 10 m from the surface of the slope. The aperture of the joints is so large that the rock mass around the church seems to be very near to collapse.

In this case, tensioned rock bolts or cables should be used to consolidate the unstable rock mass. Their length should be no less than 15 m and the head of the rock bolts should be located at the surface of the slope and in some internal cavities.

Before pre-stressing the steel bars, the large apertures in the cracks should be grouted.

The drilling of the boreholes for the installation of the anchors must be carried out by means of a rotary drilling machine to minimize dangerous vibration effects.

As can be seen in Figure 4, a great quantity of water flows along the open joints and into the church. The destructive effects of this on the painted walls are clearly visible.

3. EFFECTS OF WATER FLOW

In the four churches examined during the site visit, clear signs of water flow were noted. The main effects of water flow are the following:

a) *Local erosion caused by the mechanical effect of water flow during rainy periods, with the formation of channels and cavities.* A large cavity caused by water erosion has been noted at the rear side of Elmalı church (Figure 5) at the base of wedge B indicated in Figure 1.

- Erosion has also been observed at the base of the walls of El Nazar, to the right of the entrance door, as shown in Figure 6.

Figure 5. Erosion effect of water flow at the rear side of Elmalı church.

Figure 6. Effects of water erosion at the base of a wall of El Nazar church.

Figure 7. View of the first floor of El Nazar church showing the precarious stability conditions of the remaining structures.

Figure 8. Effects of surface erosion on the soft intermediate layer of El Nazar.

- As regards El Nazar church, it should be noted that the erosive effects of water flow are probably responsible for the collapse of part of the rock slab which covers the lower cavity shown in Figure 6. The remaining part of this slab is in a very precarious condition (as shown in Figure 7) and needs urgent installation of supporting structures.

These problems of erosion must be solved by studying very carefully the water flow modes in order to avoid water concentrations at critical points. To this end, an efficient rainwater collection system should be designed, taking into account the morphological characteristics of each site.

b) *Progressive surface erosion of the weakest layers of the rock mass.* This problem is very important for the domes of Elmalı and St Barbara, which have very poor mechanical characteristics and which undergo progressive alteration during wetting-drying cycles. Similar surface erosion has been observed in a soft, intermediate layer of El Nazar, as shown in Figure 8. The solution of surface erosion problems is very difficult, and will require the close study and the formulation of physical and chemical protection methodologies, which should then be carefully tested *in situ* under different conditions of exposure.

c) *Water percolation along the discontinuities of the rock mass.* The first effect of such percolation is a decrease in shear strength along the joints, with consequent reduction in the factor of safety. The second effect is the destruction of the

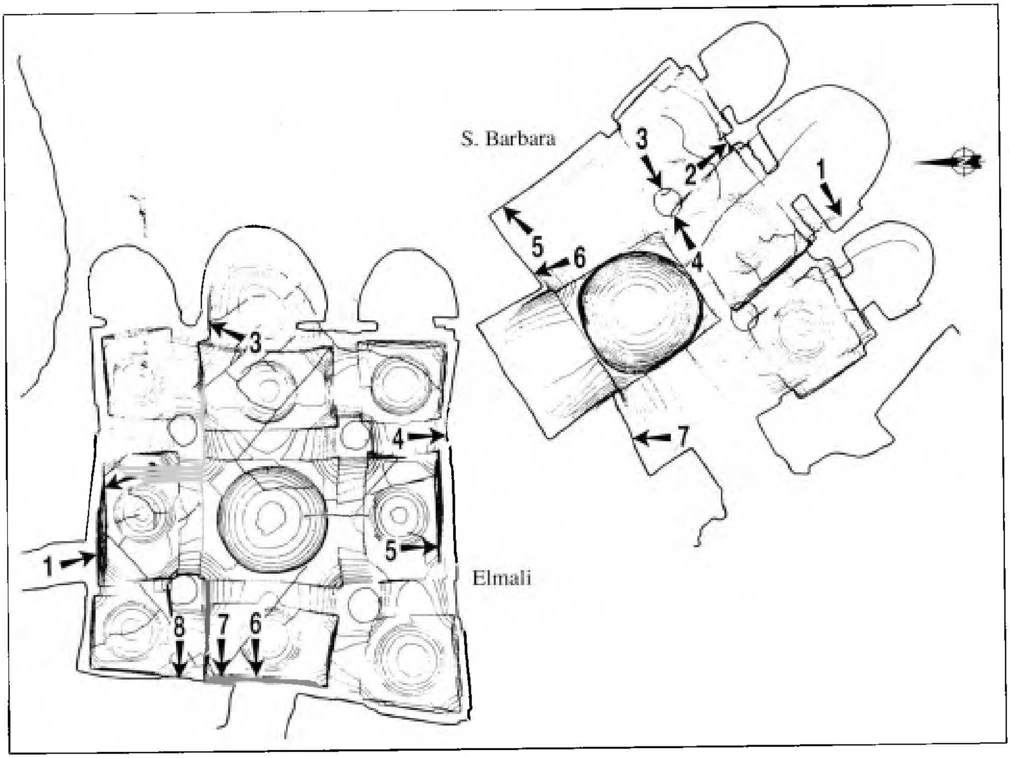

Figure 9. Layout of the monitoring points in the churches of Elmalı and St Barbara.

paintings on the walls of the churches, as observed in the churches of Elmalı, St Barbara and Meryemana (Figure 4). Owing to this progressively destructive effect, it is urgent that the flow of water into the joints be stopped. Careful sealing of the joints is required at the intersection lines between the joints themselves and the external surface of the rock mass.

4. STRUCTURAL MONITORING

As mentioned in section 2, the rock structure around the churches consists of a number of blocks separated by discontinuities or cracks. In order to understand the static behaviour of the structure and to estimate relative stability, it is vital to assess relative movements with time: how these movements are affected by seasonal thermal changes and how they progress over time. This information will assist the design of structural intervention and the definition of priorities. For this purpose, during the 1986 mission, 27 monitoring bases were installed in the main cracks observed in the four churches. A very simple and reliable instrument was chosen: a removable, mechanical strain gauge with a gauge length of 200 mm. Each monitoring point consists of three stainless steel diskettes 6 mm in diameter fixed across the crack in an equilateral triangular configuration with a side length of 200 mm. This configuration permits determination of crack movement in two directions: parallel and perpendicular to the crack. In this

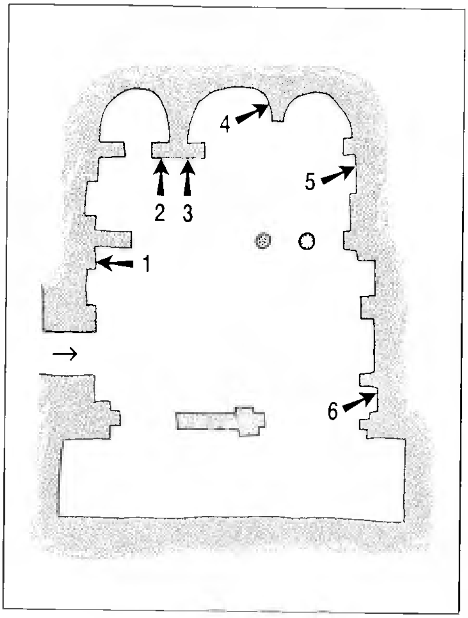

Figure 10. Layout of the monitoring points in the church of Meryemana.

Figure 11. Use of a removable mechanical strain gauge for measuring the movements of a crack in a pillar of El Nazar.

way, the opening and closing of the crack can be determined as well as its sliding movements. The monitoring points were installed in the four pilot project churches: Elmalı (8 points), St Barbara (7), El Nazar (6) and Meryemana (6). The location of the measuring points in Elmalı and St Barbara is indicated in Figure 9. The layout of the measuring points installed in Meryemana is shown in Figure 10. Figure 11 shows a detail of a measurement being performed on a pillar of El Nazar.

This preliminary monitoring system, installed in 1986, should be improved and extended to other churches, and readings should be taken at regular intervals (every one or two months). In this way it will be possible to obtain the graphs of the deformations as a function of time and temperature. In the event that large portions of the rock mass are potentially unstable, the use of a long-base, removable extensometer is suggested (Figure 12).

Rather than the installation of a permanent, automatic system, the use of a monitoring system based on manual readings was preferred for economic reasons and in view of the environmental conditions, which do not allow for easy protection of instruments, cables and reading units.

5. CONCLUDING REMARKS

Analysis of the structural conditions of the four churches clearly shows that stabilizing intervention must not be delayed. Although the causes of instability are similar in all the churches (structural conditions and water flow), it is not possible to define a generic

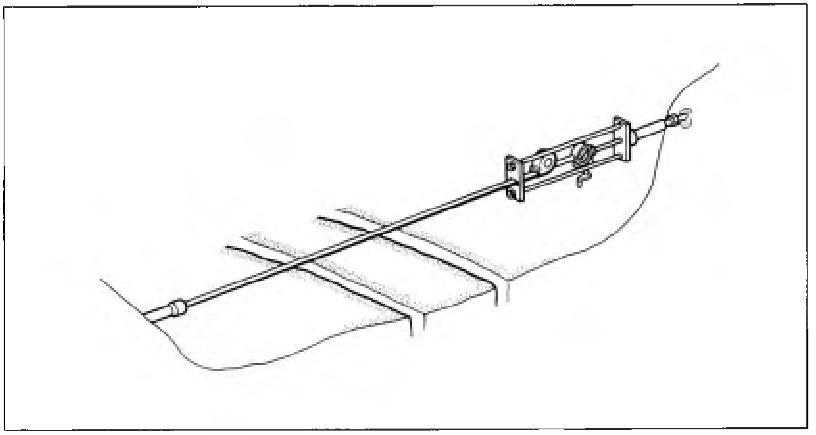

Figure 12. Long-base removable mechanical extensometer. (Length of the measuring base: up to 20 m).

stabilizing scheme that would be applicable to all four churches. On the contrary, design solutions should be studied for each case individually. It must also be remembered that access problems are different for the four churches, and this determines the type of heavy equipment and instruments that can be used. Thus, the structural consolidation of the rock-cut churches in the Göreme Valley can be effected only through a series of small-scale projects, considering each church individually. Structural monitoring will provide a significant contribution to the definition of the stabilizing solutions and will permit prompt decisions regarding intervention priority. Furthermore, after having been stabilized, the churches will need continuous maintenance and regular inspection because of the special conditions of weathering and erosion of the rock. Thus each stabilization project should be accompanied by a detailed programme for future maintenance and inspection.

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STRUCTURAL CONSOLIDATION OF EL NAZAR CHURCH

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ABSTRACT

El Nazar is one of the medieval rock-cut churches in the Göreme valley in Cappadocia. The church is carved into a freestanding conical rock which is suffering from damage caused by climatic and hydrogeological factors. The losses in the outer wall and floor of the church are signs of impending danger of further losses. In 1987, the Turkish Ministry of Culture and Tourism initiated a project to identify measures for the structural consolidation of the church. A report and a project was presented to the Ministry by the authors, covering the proposed interventions to the structure and the surrounding area.

Keywords

Architecture; historic buildings; conservation-restoration.

INTRODUCTION

El Nazar is a small-sized church carved into an isolated rock cone in the Göreme valley. It rests on a hillside, with its eastern and southern sides at a higher level. Geologically, it is within the so called Ürgüp Formation, which has tuffaceous layers at its base and lahar layers at the top. According to Erguvanlì and Erdogan, the tuff layer rises up to the church level. The surface water, which erodes and causes the alteration of volcanic rocks around El Nazar church, flows freely down the hill and enters the structure through the openings in its eastern and southern walls. The rocks around the church

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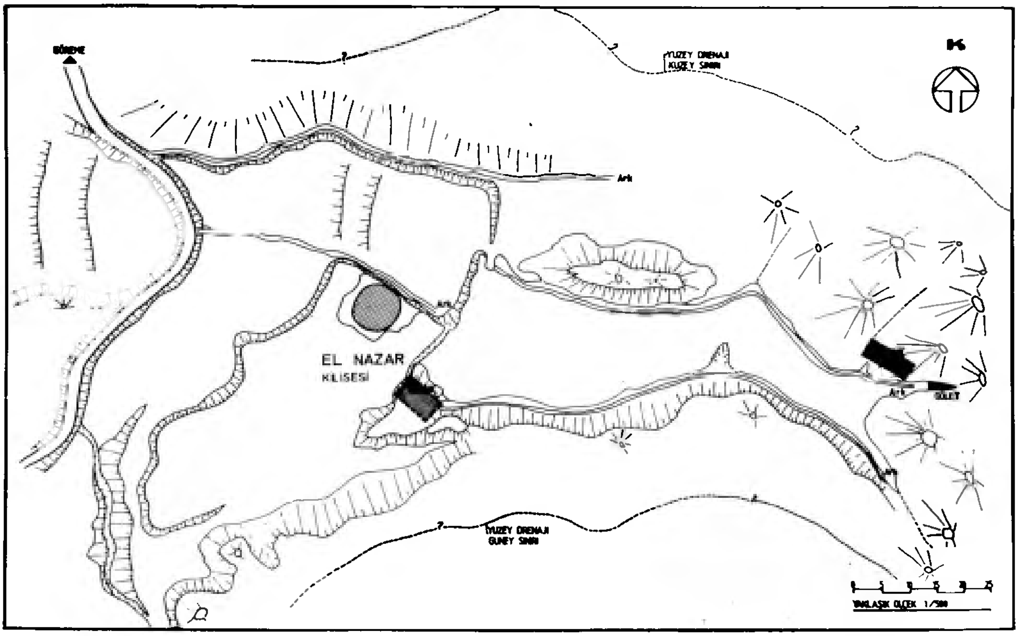

Figure 1. El Nazar and surrounding area with reservoirs and irrigation channels (Erguvanlı *et al.,* 1988)

do not permit the surface water to penetrate into the ground and move freely under the surface. Agricultural activity in the surrounding area continues, for which water is needed. Some of the underground spaces in the vicinity are used to collect and store water.

Within the El Nazar rock,there are two more levels besides the church. The lower one has an entrance on the southern facade; the other has an opening above the western entrance and is only accessible by means of an external ladder.

DECAY MECHANISMS ACTING UPON EL NAZAR

Erosion

According to the results of experiments conducted on rock specimens, the tuff surface is sensitive to water. The surface water from the surrounding area is collected by irrigation channels which are directed towards the fields surrounding El Nazar. Surface water removes the softened surface layers of the eastern and western facades and the walls at the ground level of the rock. As a result of surface water action, sole erosion has developed. The lower part of the rock has eroded, leaving the upper sections without any support. Rising damp is another factor which weakens the lower sections of the rock and speeds up erosion. As rain hits the rock, it removes particles from the surface, forming grooves which get wider and deeper in time, causing further losses from the exterior and interior surfaces of the church.

Figure 2. A detail from the southwest corner of El Nazar, showing cracks and eroded areas.

Cracks

Upon wetting by rain, water penetrates the exterior surface of the rock and is trapped there. When exposed to frost, the weakened structure of the rock is fractured. This type of crack can be seen all over the exterior surface of El Nazar rock (Figure 2). A second group of cracks, the origin of which can be associated with the previous ones, are present on the inner surface of the church, on the floor, the walls, the southeast pier, vaults and the dome (Figure 3).

Figure 3. Detail from the eastern vault and dome, with several cracks.

Collapsed part of the floor

The floor of the church has collapsed partially, leading most of the existing floor areas to act like cantilever slabs. It is easy to conclude that these will also fall down if not given some support. There are some cracks in this part of the floor. Due to the failure of the floor, the southeast pier has cracked horizontally, leaving the upper structure without support. The movements in the floor have led to the formation of further cracks on the walls.

Figure 4. A detail from the entrance to the El Nazar church, showing the overhanging western vault after the fall of the wall in that direction.

Detachment of surface crusts and thin wall sections

Cracks of different origin cause detachment from the main rock. An interesting example of a crack pattern is observed on the southern facade of the monument. There is a section which is weakly held on to the main rock; it may fall down after heavy rain or by frost action. Thin wall sections have fallen away from the eastern and western facades. The most important and problematical loss from the El Nazar rock is on the west facade (Figure 4). Some say that it fell after being hit by lightning. On an old photograph of El Nazar by de Jerphanion, the west facade is almost intact. This gap in the exterior wall has caused crack formation on the surrounding walls, vaults and the rock mass. Considering the future life of the monument, it is essential to take measures against further losses.

PROPOSED MEASURES AND STRUCTURAL REINFORCEMENT

Environmental measures

Surface water should be directed elsewhere before it reaches the church. In order to stop erosion of the rock around the base of El Nazar by the action of water dripping from the cone, the surrounding area should be reinforced with a protective layer.

The base of the cone should be protected from underground water, in case it appears. For this purpose the church should be made impervious to water from the surroundings; an open channel surrounding the base of the church at the north side could help to collect and drain surface water approaching the monument from that side.

Treatment of major defects

Erosion problems

The undercuttings at the north and west facades of the church and the south wall can be stabilized by means of new masonry walls using the local stone and a mortar made of lime and the crushed aggregate of the same rock. In order to render the structure safe against humidity problems, foundations of these walls can be made of reinforced concrete and damp-proofed.

Cracks

The thermal cracks on the exterior of the rock can be grouted by a mixture of epoxy resin, which is thermally stable, with powdered Göreme rock as filler. For this purpose, the micro-injection method recommended by the ICCROM group can be applied. The same mortar and technique can be used for the repair of cracks at the southeast pier, the floor, walls, vaults and the dome. Since the walls, the vaults and the dome are covered by frescoes, the grouting operation should be carried out with utmost care to avoid damaging the paintings.

Collapsed floor

It will be appropriate to construct a masonry wall with a concrete foundation to support the floor, which will still be in a dangerous state even after the repair of its cracks. The new wall should be similar in construction to the masonry fillings applied to the eroded parts of the ground plan and the outer face of the rock. Instead of reconstructing the missing section of the church floor, we proposed use of a temporary timber platform in order to save people from falling into the crypt.

Semi-detached surface crusts and missing wall sections

The missing parts of the walls or the weakened sections may be strengthened by the insertion of masonry supports or fillings. The big open area at the western facade presents a serious problem, the solution of which deserves careful study. In the solutions proposed by ICCROM and ISMES experts, an attempt was made to leave the broken wall as it is, after controlling the bearing capacity of the supporting system. In our calculations for testing the adequacy of the present cross sections, it was assumed that a new arch has formed (span about 8 m) between the northeast and the southwest piers. The stresses in this system were found to be within acceptable limits. If the west facade is considered as a cantilevered wall hung on to this arch, it is essential that the tensile stresses produced by the suspended section should not exceed the bearing capacity of the rock. The calculations have indicated that these stresses might reach the danger limit during saturated conditions. Consequently, we propose to construct a masonry wall, similar to the original seen on the photograph by de Jerphanion.

Protection of the outer surface from atmospheric conditions

After the completion of all repair and consolidation procedures, it will be appropriate to protect the surfaces exposed to rain by means of a protective covering. It seems that the water repellents and stone consolidants proposed by the Institute Royal du Patrimoine Artistique, Brussels, have not proved successful. We hope that the decay processes originating from weather conditions can be minimized by the results of further research.

CONCLUSION

In all of the interventions to the structural system, use of steel was deliberately avoided. This was due to potential maintenance problems as well as possible negative effects deriving from the difference between the coefficients of expansion of the rock and of steel.

The aim was to propose interventions which are discernible, can easily be differentiated from the original structure, and reversible, so that they can be removed without causing any damage to the original structure when a more appropriate material and/or technique is available.

ACKNOWLEDGEMENTS

The project for the structural consolidation of El Nazar Church is the result of a team effort by a group composed of scholars from the Architecture and Mining Faculties of Istanbul Technical University. The geological and hydrogeological aspects were studied by the late professor Dr Kemal Erguvanlı and Assoc. Prof. Dr Mustafa Erdogan. On the structural engineering side, Prof. Dr Feridun Çìlì collaborated with the authors. The photogrammetric surveys of El Nazar were provided by METU, and they constituted the basic documents for our inspections of the site and proposals for strengthening.

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TESTING THREE PRODUCTS IN GÖREME VALLEY, CAPPADOCIA

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ABSTRACT

The MPM Company (Material Protettivi Milano s.p.a.) in Italy has been working on deterioration of rocks under natural conditions, and their products are being widely used in Italy.
Between 1980 and 1984, the company experts examined the rocks in Cappadocia region and proposed three products to increase their durability *in situ.*
The products, known as *Procem-P, Isostar-C* and *Procem-S*, were tested in 25 different areas, away from the wall paintings and determined by the authorities of the Ministry and Göreme museum. The products were applied to the rocks with a brush in different concentrations. In determining the areas, orientation, heat and light factors were taken into consideration.
The report of works was presented to the Ministry in 1986. In 1988 and 1990 the tests were checked on site and documented by photographs.

Keywords

Cappadocia; field work; volcanic ash; andesite; flowlava; surface treatment; water-repellent material.

INTRODUCTION

Three MPM products, *Isostar-C*, *Procem-P* and *Procem-S*, were tested in the region of rock-hewn churches in the Göreme Valley. Twenty-five different spots were selected in the area, determined by the authorities of the General Directorate of Antiquities and Museums of the Ministry of Culture.

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The site was visited on 11 June 1986 for a general survey, and the application was carried out between 1–8 July and 13–14 September 1986.

The materials used were 15.2 l of *Isostar-C,* 18 l of *Procem-P,* 1 box of *Procem-S*, and 90 l of *Star-II*, together with 15 boxes of thickener.

SCOPE OF WORK

The proposal to test these materials was made by the Ministry of Culture in order to observe the performance in use of these three materials under natural conditions, and to assess the possibility of using these materials to solve the problems of erosion and detachment of rocks in the area.

GEOLOGY OF CAPPADOCIA

The rocks in Cappadocia consist of typical volcanic ash containing andesite and flowlava.

PROBLEMS IN THE AREA

Rainwater flowing down the rocks, especially in steep, rocky areas, leads to erosion. Rainwater penetrating into the capillary cracks in the heterogeneous structure of the tuffs, due to the changes in atmospheric conditions, freezes there and causes the cracks to get wider and, in time, parts break off the main block. Another problem is the lichens living on these rocks, which contain the minerals essential for such micro-organisms.

MATERIALS USED IN THE TESTS

- *Isostar-C* is an isocyanitic and aliphatic-based polyurethanic consolidant used in interior spaces against rainwater leakage and to fill in fine and capillary cracks.
- *Procem-P* is a siliceous and xyloxan ester-based product resistant to atmospheric conditions, preventing rainwater penetration from the exterior.
- *Procem-S* is fluorocarbon-based copolymers applied on *Procem-P* to help the process of polymerization.
- *Star-11* is a diluent which enables the penetration of the consolidant.

METHODS OF APPLICATION

Various application methods were proposed by MPM, depending on the characteristics of the rocks – such as porosity and water absorption.

- For siliceous minerals and travertine, *Procem-P* is diluted by *Star-11*, mixing the products in 1:1 proportions, and applied by brush or spray at 350-400 g/m^2.
- For sandstones and calcareous stones, the quantity should be increased to 1 500 g/m^2. Diluting with *Star-11* according to the manufacturer's instructions is recommended to ensure a better penetration of the product.
- For ceramics and terracotta, *Isostar-C* must be used diluted with *Star-11* in 1:2 proportions, and used at 1 500 g/m^2.

In all these cases, application can be by means of brush or by spray.

It must be noted that *Procem-P* and *Isostar-C* are neither of them formulated to resist lichen and fungal damage, and they cannot be used as a bonding agent or adhesive for blocks that are detaching. There are other products in the market that should be used for these purposes.

APPLICATION

Application was carried out in the region as determined by the ministry, on selected areas of rocks with different geological compositions. The orientation and inclination of rock surface was also taken into consideration (see Tables 1 to 3)

Procem-P, which prevents the passage of water to inner surfaces, was used on large areas, on various rock formations. *Isostar-C* was used in more limited areas, in inner spaces, to fill in the fine cracks.

Test areas were marked with nails and oil paint so as to be recognized easily. They were numbered, their position mapped and a photographic record made.

In Table 1, the rough dimensions of the test areas are given. Tables 2 and 3 show the description of areas selected and methods of application for *Procem-P* and *Isostar-C* respectively. In test areas 6 and 7, both products were applied side by side. In Table 4, the concentrations of diluent (*Star-11*) used with *Procem-P* are given. In Table 5, the concentrations of *Star-11* for *Isostar-C* can be seen.

Table 1. Approximate dimensions of areas to which products were applied

Area #	Length (cm)	Area (m^2)	Area #	Length (cm)	Area (m^2)
1	50×50×50×50	0.25	14	50×50×85×104	0.52
2	80×50×80×50	0.40	15	124×139×110×130	1.57
3	100×50×100×50	0.50	16	192×215×120×137	2.75
4	50×50×50×50	0.25	21	116×63×100×120	0.99
5	55×80×72×72	0.48	22	100×100×100×100	1.0
6	104×184×88×106	1.39	23	62×113×97×90	0.81
7	110×150×160×120	3.12	24	100×100×100×100	1.0
8	100×100×100×100	1.0	25	100×100×100×100	1.0
9	100×100×100×83	0.99	26	100×100×100×100	1.0
10	99×81×101×101	0.91	27	100×100×100×100	1.0
11	96×85×48×51	0.68	28	100×100×100×100	1.0
12	68×74×73×64	0.49	29	100×65×96×70	0.66
13	108×107×92×98	1.02			

Table 2. Areas where *PROCEM-P* was applied

Area #	Description of area	Position of surface	Orientation	Exposure to atm. condition	Time (Hour)	Deterioration observed	Methods of preparation
1	Entrance of vaulted space over parking area	Vertical	S	Open	11x06	Coming off in layers	Washed with water and left to dry
2	On the way west area 1 on the right	Slanting	W	Open	12x19	Coming off in powder	Washed with water and left to dry
3	20 m left of test area 2	Slanting	N	Open	15x18	Coming off in powder	Washed with water
4	Over test area 3	Slanting	N	Open	15x18	Lichen	Washed with water
5	Back of area 1, upper level	Vertical	N	Open	All day	Lichen	Washed with water; rock showing different composition
6	Upper level over the church of Tokali	Vertical	E	Open	08x13	Cracks and Lichen	Cleared with brush – dust particles between layers
8	15 m left of area 1	Slanting	W	Open	11x18	Coming off in layers	Washed with water
9	Right of area 5	Vertical	N	Open	12x18	Coming off in powder	Cleared with brush – fine surface to rocks
10	Right of area 9	Slanting	W	Half-Open	12x18	Coming off in powder	Cleared with brush – rough surface
11	Opposite area 10	Vertical	N	Half-Open	—	Cracks	Cleared with brush – polished surface
12	Next to area 11	Vertical	N	Open	—	Cracks	Cleared with brush – polished surface
13	Next to area 11	Vertical	N	Open	—	No	Cleared with brush – polished surface
14	Next to area 13	Vertical	W	Open	12x18	Lichen	Cleared with brush – rough surface
15	Upper level on the right of area 12	Vertical	W	Open	12x18	Coming off in powder	Cleared with brush – rough surface
16	To the east of area 6	Slanting	S	Open	08x16	Lichen	Cleared with brush

Table 3. Areas where *ISOSTAR-C* was applied

Area #	Description of area	Position of surface	Orientation	Exposure to atm. condition	Time (Hour)	Deterioration observed	Methods of preparation
21	Gallery on right of area 1 interior	Vertical	W	Half-Open	—	Black patina	Washed with water – fine surface
22	Interior beyond area 21	Vertical	S	Half-Open	—	Black patina	Washed with water – fine surface
23	Entrance of the same gallery (area 21)	Slanting	SW	Open	11x18	Black patina coming off in powder	Washed with water – erosion
24	6 m left of the first area	Slanting	S	Open	10x18	Lichen coming off in powder	Cleared with brush
25	Across from area 24	Slanting	N	Open	8x18	Coming off in powder	Washed with water – rough surface
26	10 m right of the first area	Vertical	S	Open	10x18	Coming off in powder	Cleared with brush – rough surface
27	15 m from area 1	Vertical	S	Open	10x18	Cracks, lichen	Cleared with brush– rough surface
28	30 m left of area 1 in the gallery	Vertical	S	Half-Open	—	Crack and water absorp.	Cleared with brush – smooth surface
29	The same gallery of area 28	Vertical	W	Half-Open	—	Cracks and black lichen	Cleared with brush – smooth surface
7	Next to area 6 (just beyond)	Vertical	E	Open	08x13	Cracks and black lichen	Cleared with brush – dust particles between layers

Table 4. *PROCEM-P* diluted with *STAR-11* and applied

Area #	m^2	Amount of PROCEM-P		Amount of STAR-11		
		to area (l)	Rate (l/m^2)	Diluted (l)	Washed (l)	Total l/m^2
1	0.25	0.375	1.50	0.75	0.0	0.75
2	0.40	0.85	2.12	0.11	0.0	0.11
3	0.50	0.25	0.50	0.75	0.75	1.50
4	0.25	0.50	2.0	0.75	0.25	1.0
5	0.48	0.50	1.04	0.50	1.0	1.50
6	1.39	2.80	2.01	3.0	3.0	6.0
7	3.12	*				
8	1.0	2.0	2.0	2.0	3.0	5.0
9	0.92	1.0	1.08	0.50	3.0	3.50
10	0.91	1.50	1.65	0.0	1.50	1.50
11	0.68	0.75	1.11	0.75	0.75	1.50
12	0.49	0.75	1.55	1.50	0.75	2.25
13	1.02	0.50	0.49	1.50	1.50	3.0
14	0.52	0.50	0.96	2.0	1.0	3.0
15	1.57	0.60	0.38	2.50	1.50	4.0
16	2.75	2.16	0.78	3.0	0.0	3.0

* *ISOSTAR-C* applied in this area.

Table 5. *ISOSTAR-C* diluted with *STAR-11* and applied

Area #	m^2	Amount of ISOSTAR-C		Amount of STAR-11		
		To area (l)	Rate (l/m^2)	Diluted (l)	Washed (l)	Total l/m^2
7	3.12	1.0	0.32	1.0	2.0	3.0
21	0.99	1.0	1.01	1.0	0.0	1.0
22	1.0	0.50	0.50	1.0	0.0	1.0
23	0.81	0.40	0.49	1.20	1.0	2.2
24	1.0	0.40	0.40	1.60	1.50	3.0
25	1.0	0.50	0.50	1.50	1.0	2.50
26	1.0	0.50	0.50	1.0	1.50	2.50
27	1.0	0.50	0.50	1.0	1.50	2.50
28	1.0	0.30	0.30	1.0	1.50	2.50
29	0.86	1.50	1.81	3.0	0.0	3.0

TEST RESULTS

In cases where the solutions were applied on slanting surfaces, it was observed that the rainwater went under the film exposed. The same thing was observed also for vertical and horizontal surfaces: rainwater found a way under the film. In 1989, a larger-scale application of the same materials was planned but this could not be realized because the materials were not available in the amounts needed.

CONCLUSIONS

It is seen that these materials are not suitable for use on exterior surfaces in trying to solve the problems in this area. But to be able to test the real performance of these products under the climatic conditions in Cappadocia region, they have to be tested on a greater scale, on the whole surfaces of rocks to be protected, filling in the cracks before application and taking precautions against microbiological growth. Further tests must be made with new adhesives and consolidants, making use of local materials.

The application must be made by experts and the condition of the surfaces must be checked at regular intervals.

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REVIEWING STRUCTURAL CONSERVATION MEASURES FOR HERITAGE RESOURCES IN ROCK

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ABSTRACT

The conservation of historic buildings is often approached from four specific viewpoints:

- the conservation of the structure itself;
- the conservation of the building envelope;
- the conservation of non-structural elements;
- the conservation of decorative finishes.

Each of these elements must be carefully considered in relation to each of the others and as a group. Sadly, our literature and experience are littered with examples of exclusive attention being paid to one element resulting in another being destroyed or seriously damaged. The classic case is perhaps the care of works of fine art in an historic building where all attention is focused on appropriate humidity levels for the fine art masterworks and consequently the building is ruined by excessive condensation forming in the walls. When we consider the conservation of historic or prehistoric resources which have been literally hewn from the living rock, have been applied to rock surfaces or have been added to existing caves and other rock formations we enter a world of some confusion. The relatively simplistic divisions between the various parts of the resource tend to fade or become grey. We also embark on a voyage into "waters" which have been explored far less by the conservation profession. To use building conservation terms, the envelope and the structure and some of the non-structural elements may all be of one material – rock. Still in its original location and probably on the site of its creation, the rock is "living" and still has groundwater or moisture moving through it. In some cultures, quarry workers carry the spirit or concept of "living rock" still further by referring to this

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moisture as quarry "sap," as though the great rock formations were like massive trees with sap flowing through their veins like life blood.

Considered in this biomorphic way the whole concept can be wonderfully romantic. However, when considering the conservation of rock-hewn resources the reality may become almost nightmarish. One can find some of humanity's greatest artistic achievements applied directly to a rock face which is not only friable, powdering, exfoliating or splitting off in layers, but is also damp or even soaking wet.

The deterioration of the "structure" may be microns deep, millimetres deep or metres deep – or all of the above!

Moisture, which may be difficult or even impossible to eliminate, may be constantly finding its way to the rear of the surface finish – bringing water-soluble salts with it, to support the growth of micro-organisms and to initiate, maintain or complete cycles of destruction.

INTRODUCTION

Before attempting to review structural conservation measures it is first necessary to examine the various forms of structural deterioration which these measures must remedy.

Structural deterioration of rock art and rock-hewn resources may possibly fall into the following categories:

1. Major physical defects in the rock formation, such as fissures, faults or cracks. These defects are particularly likely to be made more serious by actual or threatened seismic activity.
2. Minor physical defects in the rock, such as localized cracking or the presence of soft veins, layers or zones with lower load-bearing capacities relative to adjacent rock.
3. Physical and physico-chemical defects in the rock surface may result from surface induration or hardening, and changes in a wide range of characteristics or indices, including the thermal expansion coefficients of surface zones, compressive strength, modulus of rupture, and permeability – as a result of phenomena such as oxidation and water-soluble salt deposition.
4. Phenomena listed in 3. result in exfoliation or contour scaling and spalling of rock surfaces; and dis-aggregation or loss of individual grains as a result of damage to cements or binders in the rock matrix.
5. The presence of excessive amounts of moisture leads to weakening of the rock, with possibly a 50% reduction in compressive strength and modulus of rupture. Water sources are primarily surface run-off and underground aquifers.
   In semi-arid developing countries, the progressive uncontrolled removal of surface vegetation, particularly of shrubs and trees for firewood can lead to soil loss and consequent rapid and dramatic increases in water runoff. There may also be an increase in the levels of water-soluble salts coming to the surface

with increased evaporation.
Moisture may also be reaching the surface by other means, such as the strange example of the prehistoric rock art of the Tassili n'Ajjer in the "arid" Algerian Sahara. Here water was being brought to the site and poured or sprayed onto the rock surface by "guides" who thus "made the colours clearer" for visitors to the site. In this way both the rock surface and the art were being destroyed.
In association with the moisture, a secondary group of phenomena are related to the transportation and deposition of water-soluble salts and their subsequent behaviour.

(For a deeper examination of the variations in the related field of masonry conservation problems, see Weaver, 1993.)

Figure 1.
Göreme example where a large crack passes through both rock and paintings on plaster. Uncontrolled grouting operations during the stabilization of the rock substrate cannot be allowed to threaten paintings by leaks and spillage.

SOURCES OF RELEVANT NEW TECHNOLOGY

The science of conservation frequently benefits from studies in other areas of science and technology, and the subject in hand is no exception. Current developments in building conservation, mining, and civil engineering for example may be of direct relevance to the conservation of rock-hewn cultural resources.

While some of the related rock and monument stabilization technology was first developed in Italy in the 1950s (Lizzi, 1982), where subsequent examples included the use of the famous *pale radici* or root piles, other relevant work was carried out in Canada in the 1970s on the historic fortifications and cliffs of Quebec City, under the direction of the Canadian restoration engineer, Louis Dugas; and at 53, State Street, in

Boston, Massachusetts (Jokinen, 1987). Early experimental applications of synthetic resin injection for massive structural stabilization were carried out for the Canadian government at Fort №1, at Lauzon, Quebec (Leblanc, 1978). The latter experimental application is important because subsequent core drilling established exactly what degrees of penetration and consolidation had been achieved.

TRADITIONAL OR CURRENT CONSERVATION APPROACHES

The first problems which are associated with major physical defects in the rock formation consist of cracks, fissures or faults. The "traditional" approaches to this group fall into two main types.

The first type consists of bonding the rock mass together again into a cohesive whole, typically by drilling through the rock at right angles to the faults and inserting steel reinforcement in a cementitious grout or a synthetic resin-based grout in the holes – this may be termed the use of "rock anchors." Rock anchors have been extensively developed for various applications in mining in recent years. A second, older and cruder technique consisted of building masonry buttresses or bands to prevent a rock mass from moving laterally and permitting cracks to open until a collapse occurred. For most of the twentieth century such buttresses and bands have been engineered in reinforced concrete.

There are a number of difficulties which have been found to be associated with these approaches and which can be summarized as follows:

- drilling of the holes through the rock can cause excessive vibration leading to crack propagation and structural failure in fragile rock material;
- corrosion of ordinary steel reinforcement leads to an increase in the total volume of the steel plus the corrosion products. The increase in volume can easily shatter even the hardest rock material;
- the rock material is often too fragile to withstand concentrated loads and associated stresses;
- anchors may be too rigid to permit essential movements in planes perpendicular to the anchor, such as those associated with thermal expansion;
- synthetic resins are very expensive and may not be available in developing countries;
- synthetic resins may have shelf-life and pot-life problems which may be made worse by problems associated with improper storage conditions in very hot or very cold countries. The faults in the resin may then not become apparent until resins cure too quickly or do not cure at all after they have been placed. The faulty resins then cannot be practically removed because of a combination of their irreversibility and inaccessible locations.
- grouts are difficult to place accurately to avoid spillage and damage to interior finishes such as wall paintings; or loss of grout into hidden voids, e.g., into caverns and secondary fissures; and

Figures 2-3. Quebec City – Eighteenth-century fortifications being stabilized by vertical drilling and anchoring to the rock beneath with steel rods set in a grout specially designed to resist extreme freezing conditions and freeze-thaw cycles.

Figures 4-5.
Different types of Cintec Harke grout injection anchors being used in experiments in Toronto, Ontario, by the Canadian engineer Eric Jokinen.

- buttresses and bands are usually visually intrusive and aesthetically unacceptable. Such massive installations within the rock mass may also be unacceptable because they seriously interfere with interiors and interior finishes such as wall paintings.

DEVELOPMENTS IN CONSERVATION TECHNIQUES

In recent years there have been some most significant advances in the field of grout injection anchors. A system which was first used in Switzerland in 1965 by its German inventor, the engineer Alfons Harke, offers an excellent solution to a wide range of stabilization and conservation projects without the associated problems mentioned above. Since the initial use, a large number of variations have been developed and applied in Europe; and since 1991 in Canada and the USA (Weaver, 1991).

The Cintec Harke anchor system, which is manufactured by Cavity Lock Systems Ltd of Newport, Gwent, United Kingdom, has been developed to be easily fixed even in weak materials. It reinforces materials of inferior structural properties and is capable of bridging cavities.

It is sympathetic with existing structures and can be designed to accommodate movement in certain directions and planes while simultaneously resisting or restraining movement in others. The system is versatile, quickly installed and is permanent, i.e., non-deteriorating, even resisting explosions, high temperature fires and corrosive conditions (Cintec Harke, 1993). Developments in diamond drilling technology and in high quality cementitious grouts have been incorporated into the system.

The basic system, which is protected by international patents, is ingenious and elegant in its simplicity. The main body of the simplest type of anchor is a stainless steel tube that carries and transfers loads. The stainless steel tube may be square or round in cross section, with thick or thin walls as required. The tube is completely surrounded by a fabric "sock" or "sleeve" made of polyester textile. The wrapped anchor is placed in a hole drilled to be approximately twice the diameter of the anchor. The holes are normally drilled with a diamond-tipped coring bit.

A specially formulated low-alkali, sulphate-resisting cementitious grout, known as *Presstec*, is then injected at low pressure through the middle of the anchor. Normal injection pressure is approximately 40 psi (275 kPa). When the grout reaches the end of the anchor tube it flows out through a series of grout flood holes into the fabric sleeve. The entire assembly then inflates like a grout or mortar-filled balloon. The excess "milk" or fluid of the grout and bonding agent combined, passes through the fabric sleeve, fixing the anchor and providing mechanical and chemical bonds to the parent material. Variations in the size and shape of the individual components make it possible to alter the basic method to meet the designers' requirements. By using separate but linked tubes with their own separate flood holes and fabric sleeves, it is possible to stabilize and connect widely separated masses of relatively fragile material.

Variations in the size, shape and arrangements of the different components make it possible for the basic method to be modified to meet the specific requirements of each application as determined by the engineer/designer.

A few years ago, 30 metre (98 ft) long anchors were used to stabilize the harbour walls at Zeebrugge, Belgium. Stitching anchors 9 metres (30 ft) in length have been used regularly during the last 20 years, and a broad range of specifications have been developed to solve different specific requirements (Weaver, 1991).

In certain cases, increasing the diameter of the sleeves and hence the solidified grout masses makes it possible for loads to be spread over larger areas and thus, since stresses on the rock material are reduced, even very weak materials can easily be stabilized.

Drilling is typically carried out using diamond-tipped coring bits that cause minimal vibration. Although drilling is normally carried out with water or air mist supplies, special techniques for dry diamond drilling have been developed for situations in which lubricating or cooling water could cause unacceptable risks to delicate stone and decorative paints for example.

Using two separately inflated sleeves on a single tube means that grout – and hence bond – can be located within rock masses and kept away from large voids or cavities where it would serve no purpose and would be wasted. The central section of the tube between the grout masses can thus be designed to be flexible enough to accommodate differences in thermal expansion between a sun-warmed rock surface and an unwarmed interior zone. The anchors can be used on a much smaller scale to attach delaminating surface slabs to rock masses – such small anchors include 10 mm external diameter tubes with 1 mm thick walls, and a short 4 mm diameter stainless steel rod with a flexible plastic injection tube.

Injection anchors may also be used to transfer or re-distribute loads to reduce stresses on weak or soft veins or zones of low load-bearing capacity.

Although this paper concentrates on purely structural conservation issues rather than surface consolidation and the prevention of particle loss or erosion by various means, it is necessary to discuss issues which are not immediately obviously of a structural nature.

WATER-RELATED DETERIORATION AND COUNTERMEASURES

The importance of the rôles of water in affecting the long-term conservation of rock-hewn resources has been well established and cannot be overestimated.

The rôles are principally as follows:

- The presence of water in the pores and capillaries of the rock material can substantially reduce the strength of the rock material as a whole. Compression strength and modulus of rupture are particularly affected. Compression strengths of wet material may be half those of similar materials when dry, e.g., for a sandstone from the Gulf Islands, British Columbia: crushing strength when

Figures 6-7-8-9. Sequence (clockwise from upper left) taken over ten seconds showing pressure vessel for grout, then the inflation of an anchor and its removal from the injection nozzle.

Figure 10.
This massive steel test rig subsequently collapsed at a load greatly in excess of the anchors' design load. The Cintec Harke anchors themselves did not fail.

dry – 8 551 psi; c.s. when wet – 3 963 psi; and wet after freezing – 2 052 psi; and for an andesite from Haddington Island, BC: a crushing strength of 18 428 psi dry; 13 847 psi wet; and 11 415 psi wet after freezing (Parks, 1917: 188).

- It has been noted that damage is more likely to occur during thermal expansion processes or heating and cooling cycles in rock where moisture is also present (Winkler, 1975: 44).
- Water can remove binding material from the rock mass, thus lowering the strength of the mass.
- Water can be responsible for the re-deposition of water-soluble salts and binding media in surface zones, and hence for associated damage.
- The freezing of water in the rock mass and in fissures with associated hydrostatic pressures and ice pressures may cause structural deterioration or even rapid catastrophic failure.
- Water is also the key to a large range of surface deterioration phenomena, including the growth of bacteria and other agents of biodeterioration.

If the rôle of water in the rock mass has been established as being structurally harmful, then it follows that the removal of water or at least a reduction in the volume of water could be structurally beneficial. Thus the removal or reduction of water can be seen to be a structural conservation measure.

In practice, the total removal of water from rock masses may be impossible, but a reduction in volume may be quite feasible and very useful.

Careful hydrogeological studies should reveal the principal sources of water and the pattern of water flow through the rock mass. Surface drainage over exposed rock surfaces and the associated runoff have usually proved subsequently to be major sources of damaging water within the rock mass. Happily such sources can be comparatively easy to treat by the diversion of water away from harmful runoff stream routes or flows, towards less harmful directions.

Subterranean aquifers may also be drilled into to divert water or they may be traced back to more readily accessible sources which can then be diverted.

The treatment of exposed rock in surface drainage channels with water repellents or even waterproof coatings may also prove to be an acceptable and useful practice under carefully controlled conditions.

CONCLUSIONS

There has been much argument in recent years concerning the large-scale "non-reversible" interventions which have been carried out on some of the world's greatest monuments to stabilize them and in some cases to prevent their imminent or threatened collapse.

Clearly the opponents to such stabilizations cannot reasonably base their opposition purely on the fact that the stabilizations are irreversible. When an historic castle or city wall is threatening to fall off a cliff, or a church is sliding down a steep slope they must be anchored and further movement prevented or they will be lost.

Endless debates on whether the stabilization method is reversible are pointless especially since the threatened collapse or loss is not reversible once it has occurred. It must first be remembered that the primary reason for the criterion of reversibility is that in the past untested or poorly designed or executed conservation processes and media have failed and have needed to be removed. A more realistic approach lies in clearly defining the appropriate criteria which stabilization techniques and materials must satisfy, and then controlling quality on the job to ensure that all the criteria are met. The theoretical requirement that one should be able to reverse the process and remove the stabilization media and reinforcement, for example, is then no longer relevant or necessary.

The rock-hewn monument is a classic example of a dichotomy where great masses of extremely heavy material may be simultaneously both brittle and fragile. They may also be covered with very thin layers of brittle and fragile decorative finishes made of other materials. In this paper it has been shown that by careful design and ingenuity it is possible to design structural conservation systems which are capable of stabilizing great rock masses (and massive masonry) without damaging decorated surfaces. Such systems can also be employed over a very large range of scales – from 30 cm to 30 metres in length. It has also been shown that excellent as these systems are, the damaging rôle of water cannot be ignored, and that moisture levels must simultaneously be controlled to acceptable limits.

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THE OBJECTIVES OF THE INTERNATIONAL MURAL PAINTING CONSERVATION PROJECT (GÖREME, 1973-1990)

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ABSTRACT

In 1973, the first international mission, organized by ICCROM experts together with the specialists of the Middle East Technical University, Ministry of Culture and Ministry of Tourism, began the conservation and the restoration of the mural paintings present in the different churches of the Göreme region, and continued the interventions until 1990. Temporary structural conservation treatments were also applied to several buildings to arrest the entry of water until permanent solutions for these problems are undertaken in the region.

Keywords

Conservation; mural painting; ICCROM; Göreme valley; natural erosion; documentation; consolidation; rendering; cohesion; adhesion; pigment layer; surface accumulation; maintenance; tourism.

Göreme valley is in Cappadocia, and lies within the volcanic area of Mount Erciyas and Mount Hasan in central Anatolia. During the Miocene period, basaltic lava flows covered the area, and, later, during the Pliocene period, lavas and overlying beds of ash were deposited by Mount Erciyas.

Finally, during the Late Pliocene and Early Pleistocene periods, both of the volcanoes were intensively active and basaltic lava flowed over some parts of the ash beds. The volcanic ash falls were consolidated into tuff by the weight of the overlying deposits and where they had no protective coverings of basalt, they eroded easily.

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Figure 1. Rock-hewn structures in the Göreme valley.

Figure 2 Geometric designs of ochre colors applied directly on the rock surface, polychrome paint layer on the rendering, big losses on the vault (Tokalı).

Figure 3. High relief decoration.

Figure 4. Deep crack in the rock.

Natural causes – such as wind and rain – have created in the area over the centuries a variety of shapes, including isolated or groups of cones, pyramids, towers or deep valleys and canyons. Some of these reach a height of 30 to 40 m, some cling to the hillsides, others are grouped at the bottom of the valleys and some are isolated monoliths jutting skyward (Figure 1).

Since the fourth century AD, these easily workable tuff rocks have been hollowed out by communities, which carved and decorated churches, chapels, monasteries and underground cities in the soft volcanic spires and cliffs. The decorative art in these churches can be classified as:

- Simple geometric designs applied directly to the rock surface, where predominant colours are red (ochre), green, black or sometimes yellow (Figure 2).
- Religious figures or saints painted in polychrome on a thin or thick layer of plaster (Figure 2).
- High-relief decoration carved directly onto the volcanic tuff rock (Figure 3).

Göreme valley, which was chosen as the primary zone from the point of view of the needs for structural conservation and the rescue of the wall paintings, shows deterioration in several dimensions:

- Climatic factors such as winds, rain and frost cause wear, fracturing and cracking of the surface of the rocks (Figure 4).

Figure 5. Alteration of pigment.

- Water leaking through the cracks into the deep grooves and crevices in winter causes mechanical tension within the rock because of repetitive frost action. Consequently, when water reaches in the structures it accumulates between the rendering and the rock surface behind, which cause the mural painting to split and fall in large pieces (Figure 2).
- Capillarity due to the leaking water also causes alteration of pigments (Figure 5), promotes micro-organism growth, and the formation of salts and calcareous layers on the surfaces.
- Vandalism in the past and high touristic activity today causes voluntary or involuntary damage in the buildings and on the wall paintings (Figure 6).

The first attempts to start the conservation project for the rescue of the mural paintings in the rock-hewn churches in the Göreme region go back to 1971. In 1972, a detailed programme for the overall conservation problems of the area was prepared by ICCROM and presented to the Turkish authorities. In the same year Prof. P. Mora and Prof. G. Torraca visited the site, and in 1973 the first international mission began salvage activities in the region. The mission was organized by ICCROM, and comprised international experts together with the specialists of the Middle East Technical University, the Ministry of Culture and the Ministry of Tourism.

The project had a dual purpose:

- to carry out emergency consolidation for conservation of the mural paintings;
- to give assistance in the training of a Turkish team of restorers.

Figure 6. Deliberate graffiti and scratches on the paint layer (Karanlık).

Figure 7. Re-attachment of the rendering to the support.

The interventions applied within the framework of the project included:

- A detailed documentation of the technique of execution, the state of the deterioration of the support, the rendering, the paint layer and the surface accumulations, as well as the different treatments applied in the conservation of the mural paintings.
- Consolidation of the support (volcanic tuff rock).
- Re-attachment of the rendering to the rock proper and consolidation of the rendering itself.
- Consolidation of the pigmented layer, reinforcing its cohesion and adhesion.
- Removal of the dust layer and other types of surface accumulations on the pigmented layer, with the help of mechanical and chemical methods.

Figure 8. Temporary overshed (Kılıçlar).

- Filling the deep cracks and the lacunae of the support, as well as the rendering, with suitable mortar.
- Re-integration.

From 1973 to 1980, eight successive missions were carried out by ICCROM and Turkish teams, dealing principally with the conservation of the mural paintings in the biggest church of the Göreme region where the detachment of plaster layers was discovered by the experts of ICCROM to be in a very bad state, and the building was chosen as the principal site of intervention.

In 1980, Tokalı church was opened to the public, and from 1981 until 1990 successive missions were carried out on the conservation of the wall paintings in Karanlık church. The conservation team not only dealt with these two churches but also made some rescue interventions on mural paintings elsewhere that showed danger of falling down and on buildings that had structural problems.

In Elmalı church, the rendering as well as the paint layer was consolidated (Figure 7). Due to natural erosion, the rainwater that leaked through the deep cracks and grooves on the top of Elmalı and Barbara complexes affected the wall paintings inside these structures. The eroded areas on the top were filled with suitable mortar (tuff powder, lime and sand mixture), a wire net was set on the top to provide a visible control of the depth of the erosion and this was covered again with mortar.

In Kılıçlar church in the Kılıçlar valley, the dust and other surface accumulations on the mural paintings were lifted by various treatment methods and the paint layer was consolidated. The rendering of the main cupola and of the other areas was re-attached to the support and the edges were filled with suitable mortar. The rainwater was leaking from the top of the entrance and there was a hole in the roof of the chapel next to the church. This hole was filled with mortar and an overshed similar to the tuff rock in the area was built temporarily over the entrance to stop rainwater getting into the structure (Figure 8).

Figure 9. The hole on the support and the mud layer covering the mural painting just underneath (Saklı).

In 1981, an urgent intervention was carried on in the small chapel within the complex of monastery of Nuns, where the surface accumulations were lifted, both the paint layer as well as the rendering was consolidated, and the detached edges of the rendering were filled with suitable mortar.

In 1987, taking advantage of the presence of scaffolding in El Nazar church, surface accumulations on the mural paintings were cleaned in the reachable areas, the paint layer was consolidated and some of the lacunae were filled with suitable mortar. Some injections were also applied between the rendering and the supporting tuff rock.

Saklı church has a weak and tender tuff that is practically powdering, especially towards the rear of the structure. The cultivated field on the top of the church also plays a major role in the deterioration processes. Just beside the steps that lead down to the entrance, a hole was formed and rainwater was running down the mural paintings on the western side (Figure 9); in that area the paint layer was covered with mud. The area around the hole was consolidated and a piece of tuff rock was shaped to fit the hole. It was set in, covered around and over with suitable mortar (hydraulic lime, sand and tuff powder mixture). The same hole was covered inside the building with refined mortar (slaked lime, sand and refined tuff powder). The mud on the paint layer was softened with Japanese tissue paper compresses and it was lifted mechanically. To prevent rainwater entering the church, the flow of the water was diverted and an overshed similar to the tuff rock in the area was built over the entrance. These oversheds are considered to be only temporary, and they will be removed when the structural conservation interventions in the region start to provide permanent solutions for such fundamental problems. Göreme valley is an area where even if the conservation measures are completed, there will always be the necessity for a never-ending series of maintenance controls and emergency measures. A small staff of technicians are always needed to monitor the area year-round.

The site should also be prepared for the touristic access that is already becoming a major erosion factor. This unique site should be preserved as it is for future generations – it is a cultural heritage that belongs to all Mankind.

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On behalf of the team, I would like to express our sincere gratitude to Prof. P. Mora, who started the project in 1972 and also gave his advice on the work during his visit in 1976; to Sir Bernard Feilden (Director of ICCROM in 1979) who also visited and inspected the project; to Prof. C. Erder who backed us up, either from Ankara or from Rome as ICCROM Director; to Prof. A. Tomaszewski as former ICCROM Director; to UNESCO and ICCROM for their supply of chemicals and other equipment necessary for the project. We thank all the foreign and Turkish experts and participants who took part in the project, especially P. Schwartzbaum (ICCROM Mural Painting Coordinator at that time), who joined us in 1976 and worked as Field Supervisor of Tokalı church until 1980, and also provided to the project the portable scaffolding, and I. Dangas who joined the team in 1975 and who was the Field Supervisor of Karanlık church between 1981-1990, for her patience and valuable contributions during this long period of activities.

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CONSERVATION OF MURAL PAINTINGS OF THE KARANLIK CHURCH, GÖREME (TURKEY)

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ABSTRACT

Conservation-restoration in the Göreme context had many unusual features. The intervention was complex because of a largely new team of workers in the field, the extreme degradation of the paintings and the difficult work conditions, such as dark, confined atmospheres and cramped working areas within a sophisticated architectural context. Treatment required some external structural interventions and important work on reinforcement of adhesion and cohesion of the constituent materials (rock, rendering, paint layer). Cleaning was a delicate phase due to the fragility of the original technique and the quantity of heterogenous surface accumulations and staining. The aesthetic presentation was especially complex because of innumerable alterations due to vandalism, necessitating an appropriate particular approach.

INTRODUCTION

In the joint Turkish Government – ICCROM campaign for saving the churches of Göreme, very important work of conservation and restoration was done in Karanlık Kilise, with a two-fold objective: to train a Turkish team[1] to undertake the protection of the numerous menaced paintings in Cappadocia, and to restore some of them.

Between 1979 and 1990, this undertaking developed into a yearly six-week intervention by a team of 6 to 9 people, who in addition to the work carried out in Karanlık Kilise – the focus of the operation – also effected conservation treatments in many of the other very affected churches in Göreme, such as Tokalı, Kızlar, Elmalı, Kılıçlar, El Nazar and Saklı. Interventions involved structural treatments when they directly affected works of art, and the treatment of paintings, including reinforcing renderings and paint layers.

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ARCHITECTURAL COMPLEX

Karanlık Kilise is situated on top of the hemicycle of the Göreme Open Air Museum.

The Monastery and Dark Church are rock-hewn monuments. They are distributed all around a "courtyard," whose northern side collapsed. On the eastern wall, the church's facade is very simple: a small door surmounted by a tympanum once painted (traces of two decorations: one directly on the rock, the other on plaster) and a small window, above on the right side.

The entrance, by stairway, leads to the narthex (Figure 1), weakly illuminated by the window. It is a rectangle with a barrel-vault and a small tomb chamber on the south side. The peculiar orientation, facing south, is probably because of the rock. In the eastern wall, entry to the nave is through a door and an opening, today widened.

The naos (Figure 1), dark, whence the church's name, is a cross-square room with four freestanding columns, a main apse and two small lateral apses (prothesis and diaconicon) preceded by chancels.

The main cupolas are surmounted by drums, the others, on the four corners are smaller, the rest is barrel-vaulted.

PAINTINGS

Exterior paintings

Mary with Child and Saints, situated at the right of the facade.

Interior paintings

Paintings are dated either middle eleventh, or end twelfth or early thirteenth century, according to different specialists' opinions.

The church includes a New Testament cycle (listed below), several donor images, saints, prophets, martyrs, the four Evangelists and some Old Testament scenes.

In the naos are:

Entry into Jerusalem	№7
Journey to Bethlehem	№1
Last Supper	№8
Nativity	№2
Betrayal	№9
Adoration of the Magi	№3
Crucifixion	№10
Baptism	№4
Anastasis	№11
Raising of Lazarus	№5
Women to Empty Tomb	№12
Transfiguration	№6
Three Young Men in the Fiery Furnace	№13

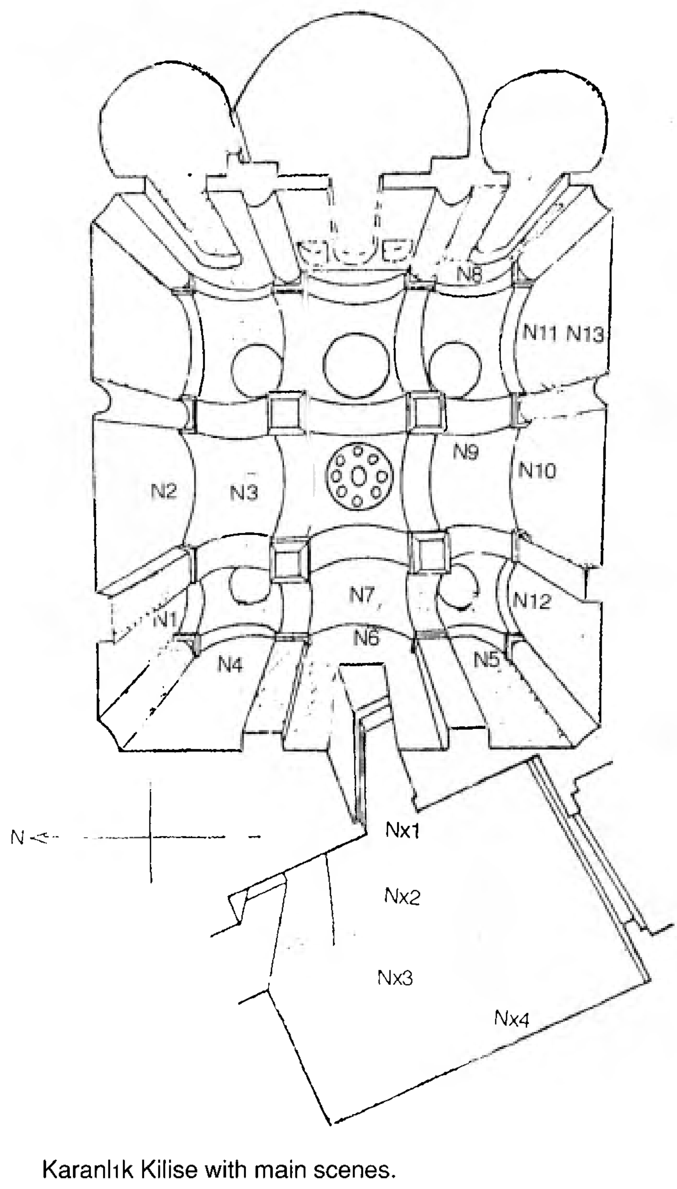

Figure 1. Karanlık Kilise with main scenes.

In the apses and cupolas are:

Deisis	(main apse)
Christ blessing	(east dome)
Virgin with infant Jesus	(protesis)
Christ blessing	(main dome)
Abraham	(diaconicon)
Archangels	
Holy Face	(diaconicon)

In the narthex are:

Annunciation	Nx1
Blessing and Mission of the Apostles	Nx2
Ascension	Nx3
Hospitality of Abraham	Nx4

Scenes and personages are indicated with white Greek inscriptions.

ORNAMENTATION

The ornaments' repertory is rich and diversified in manner (head bands, plates, etc.), in order to underline the architectural elements or to adorn clothes and caps: gadrooned half flowers, acanthus leaves, olive chaplets, pearl cordons, tallow-topped, Kufic elements, and various marble imitations.

TECHNIQUES OF EXECUTION

A characteristic feature of the wall painting techniques in Cappadocia is the wide-ranging possibilities exploited by individual workshops, whose practices were based on local geographical conditions. In Karanlık, first adorned with geometric red and green paintings directly on the rock (iconoclast period), the technique of the present decor is as follows:

Support

Tuff hewn and tooled.

Plaster

One layer, composed of lime and tuff with a small amount of finely ground sand, ground straw, and casein. Irregularly applied on the rock, 2 to 10 mm thick, following its casual deep depressions and according to quite large architectural spaces (except for the main apse, where it is used on small areas, aureoles and the heads of Christ, Mary and John). Smoothed with little trowels.

Paint layer

The sketch is quickly made with diluted red ochre. The paint is gradually applied with casein[2] and eventually other binding media; the last touches, added in order to model some shapes, seem to be lacquer (vegetable gums?). An exception is the three heads in the main apse, where they used a fresco technique, according to the setting of the rendering and nail prints of the artist which marked the fresh mortar.

The background colour is blue-grey obtained with two layers: black (burnt earth, carbon) then a mixture of white and black. In some cases, as in the diaconicon, grey is posed on a thin white layer, according to analyses. Colours are used pure or combined together: white, black, yellow, reds, green, pink, grey. The palette is clearest in the narthex.

A compass was used to trace aureoles (hole + incisions).

Coating

The lower parts of the paintings, which are within reach of humans, are covered with a protective film, which was useful, but altered chromatically .

ALTERATION PHENOMENA

Structural alterations

On the top of the church and upper facade, cracks, erosion and vegetation caused damp. In the courtyard, on the northeastern part, rainwater runoff eroded the tuff and the paint layer (I°st decor), and in the western part the rock was weakened in some parts. At the extreme upper point of the overhanging rock, a "hat block" threatened to fall down.

Rock alterations

The church's stability was once compromised by the lack of three of the four columns that support the naos (reconstructed some decades ago) and the fall of one part of the communicating wall between the narthex and the naos (still not reinforced).

Lesions affected the support in different parts: in the choir, the chancel screen is half destroyed; elsewhere, cracks, especially deep in the prothesis and northeast side, are caused by the support's movements, and holes due to a previous transformation into a pigeon coop.

Oil and wax deposits have strongly spotted the altars and the chancels.

Rendering alterations

Significant lack of cohesion and adhesion. Abrasions due to frequentation and use as pigeon coop; burns and multiple lesions, such as impacts, scratches, graffiti[3] and markings, due to usage and vandalism.

Paint layer alterations

General lack of cohesion and important scaling phenomena. Abrasion phenomena[4] and multiple lesions due to frequentation, vandalism and inappropriate use, altered the paintings significantly, with a special intensity on lower parts (some scenes are 50% destroyed). Elsewhere, the most affected parts are the eyes, the hands and the inscriptions.

Occasional burns from lighting and other phenomena caused by the original technique, such as the straw contained in the mortar surface, leading to scaling or glazing.

Chromatic changes such as general darkening, especially in the apses and on the blue-grey background colour, or in areas obscured by infiltrations and tiny local blackish spots due to pigment alteration (for example, lead was found in samples analysed).

Carbonate and sulphate deposits in infiltration areas formed deep encrustations, scaling and staining. In addition, there were innumerable stains due to frequentation and vandalism, such as oil, lampblack, candle, guano, charcoal, chalk, mud, glue, ink, lipstick, chewing gum and cement from the column restoration intervention.

TREATMENTS

Graphic and photographic documentation

A conservation map was drawn up for the whole church and continuously updated as work progressed. On the paintings, recorded with linear drawings, characteristic features have been successively added concerning the original technique, the state of preservation of each layer (rock, rendering, paint layer), surface deposits and interventions.

Complete photographic documentation was carried out before, during and after the conservation and restoration work.

Structural treatment

On the church's roof and in some areas in the monastery courtyard, intervention consisted of removing vegetation and earth, reinforcing the tuff's cohesion, filling cracks and diverting runoff.

Painting treatments[5]

Treatments were context-specific, according to each alteration, with some evolution over time. In addition to intense alterations, the elaborate architectural shapes (arches, domes) in such awkward places, the lack of oxygen and the artificial light made the work more difficult.

Furthermore, the extensive damage required a special approach to restore the quality of the work of art without interfering with its authenticity.

Support consolidation

Rock cracks were filled with grout-mortar, charged with gravel and stone.

Rendering consolidation

The detached parts were treated, after eventual facing, for cohesion (*Primal AC 33*, 10% in water and *Paraloid B 72*, 3 to 6% in thinner) and adhesion (lime caseate and hydraulic lime grout + barium hydroxide and sodium gluconate), and maintained under pressure. There were particular difficulties due to architectural features and the rock's irregularities.

Paint layer consolidation

Cohesion reinforcement was given by low concentrations of *Paraloid B 72* in thinner, according to special needs (cartography).

Adhesion reinforcement was given by *Primal AC 33*, using a 10 to 15% emulsion, by injection and spatula levelling through a plastic film. When necessary a primary increase of cohesive power was made. In some cases a facing was used with Japanese paper or gauze and *Paraloid B 72* at 15% in acetone.

Cleaning

Different kinds of dirt were removed progressively in specific ways from the upper layers. After a selection of the products, percentages and implementation approach, treatment was done mechanically (dry absorbent sponges, scalpels and dentistry tools) and by chemical action (ammonium and sodium carbonates, *Idranal*, butylamine, carbon tetrachloride, acetone), used by preference through paper paste.

The cleaning often entailed an intermediate reinforcing of the paint layer's cohesion, after having removed dust or superficial stains.

Reference to past documentation

Consultation of old photographs and texts – especially Jerphanion's works – was very useful for very damaged parts.

Presentation

Criteria

Working on the assumption that an image's effect is disturbed by lacunae in two ways, namely the colour contrasts badly and the lacunae break the continuity of the images, and with due respect for aesthetic and historical points of view, the criteria for our interventions were:

- to restore the image to pre-eminence, and
- to reconstitute the missing part, but with differentiation.

A diagnosis was made of the paint layer's state of wear and of lacunae, making a distinction between:

- lacunae whose re-integration was possible and desirable, and
- lacunae whose re-integration might impair the authenticity of the work of art.

Operations[6]

Working out from standard basic criteria, we had to define a special methodology for Karanlik, because of its extensive damage, addressing both obvious and doubtful elements, such as:

- Wear of the paint layer.
  This included abrasions, flaking, and small scratches, which were treated and tinted using a toned-down colour close to but distinct from the adjacent original colours.

- Lacunae amenable to restoration.
  Exceptional treatment was carried out in the main apse, where some details have been fully completed with a mortar fill to surface level, followed by *tratteggio*[7] treatment. The choice was established with a view to providing the team with a broad range of tasks and techniques as part of their training.

  The selection of the general treatment was predicated by the doubtful possibility of treating such a quantity of lacunae "traditionally" (i.e., in the previously accepted manner) without affecting the painting's authenticity, and also by the comparative inexperience and short working period of each team, which limited the rate of progress.[8]

  We opted for a special approach, namely either re-integrating the lacunae as they were, or slightly reducing their depth by adding a little mortar (respecting abrasion phenomena). The restoration remains perceptible without affecting the image.
- Lacunae not amenable to re-integration
  Where the pictorial element lost could not be resurrected (e.g., some characteristic details from faces, hands, feet, attributes, inscriptions, etc.) or where they were extensive, they could not be filled.

  Treatment in this case consisted of merging each lacuna into its general background, i.e., slightly obscuring its tonality and, if necessary, filling the deepest holes with a mortar similar to the original in composition, texture and colour. In that way, the lacunae assume a uniform, unobtrusive tonality and do not disturb perception of the image.

Conclusions

This experience has proved once more the unique nature of any intervention, although based on established ethical criteria. The very successful result of the conservation and restoration of the Dark Church is due to the joint efforts of the Turkish Ministry of Culture and Tourism, ICCROM and the team.

Although one feels it necessary to stress once again that the efficacy of such work is strictly dependent on regular maintenance, and that other churches still require attention, it nevertheless remains to wish for a happy future for Karanlik Kilise and all Cappadocia, founded on a wise and good interdisciplinarity.

NOTES

1. Each team comprised 1 or 2 ICCROM restorers, and 5-7 archaeologists on loan from the Turkish Ministry of Culture and Tourism, directed by R. Ozil, who was responsible for the Göreme activities for 17 years.

2. Analyses were carried out by L.R.M.H. and ARMEDIS (France).
3. Graffiti have been scratched by visitors since at least the seventeenth century to modern times. Dates are marked in Turkish and arabic numerals. According to Jerphanion, Karanlik Kilise was the church in Göreme most frequented by travellers, by Ürgüp's ethnic Greeks and Machan's Muslims. Recent intensive tourism has also contributed to the destruction.
4. Ancient coating preserved well enough the paintings' lowest third, while higher parts are extremely affected by horizontal rubbing abrasion.
5. Paintings include the unique outside scene "Mary and Saints."
6. Pictorial re-integration: pigments used were either watercolours (Winsor & Newton) in a stable range, or local red iron oxide; and the mortar used for restoration was very similar to the original in composition, granulometry, texture and colour.
7. *Tratteggio* is a re-integration method employing a fine vertical hatch of different colours, developed by the Istituto Centrale del Restauro, Rome.
8. Ability: long experience is required for sealing innumerable lacunae and filling up to the surrounding level with mortar (with the risk of introducing undesirable effects such as irregularities or shining), and for carrying out tratteggio treatments.

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WALL PAINTINGS IN THE CHURCH OF KALEKILISE AT TATLARIN:

REMOVAL OF LAMPBLACK DEPOSITS AND MEASURES FOR THEIR CONSERVATION

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INTRODUCTION

Today there exists within the municipal limits of the town of Tatlarin, which lies in the district of Acıgöl in the province of Nevshehir, an elevated prominence of tuff, overlaid by a lava flow, whose form resembles a citadel. Carved deeply into the heart of this natural formation are some scattered houses, an underground city and, so far as was known until recently, four churches; however, in the course of my fieldwork, I discovered one other church, whose entrance had long before – perhaps one hundred to one hundred fifty years ago – become blocked by a fallen boulder. In addition, there exists a large settlement site on the floor of the valley where today stands a mosque said to have been built in the time of Damat Brahim Pasha (early eighteenth century) and constructed of stone coursework, covered by a flat roof and bearing at one corner a minaret of dressed stone.

Due to the sporadic threat of collapse to which the houses carved out of the rock are subject, this region was declared by the state to be a natural disaster area. Residents of these houses have been relocated to housing constructed on a flat plain in the valley. The rock houses are now uninhabited though some of them are in use as granaries.

The name "Tatlarin" derives from its former name of "Tatarini," so called because the residents of the rock houses were of Tartar (Turkish: *Tatar*) origin; over time this name took on its present form.

The current municipal mayor, Hilmi Biltekin, initiated a clean-up campaign for the subterranean city and built a road leading to its entrance with the aim of attracting

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visitors to the area. Noticing, in one of the two churches near the underground city, that the wall paintings whose surfaces were covered in their entirety by lampblack deposits had, apparently, been damaged by attempts under the previous mayor to clean them with water, detergent and a brush, the mayor decided to put in a request to the Directorate General for Cultural and Natural Properties for an expert to clean them.

Commissioned by the same directorate to ascertain what was required to bring the paintings to light and to report on their condition, I was able, based on my examination of the paintings and tests carried out on them in October 1990, to state that the surfaces of the walls – completely overlaid with deposits of lampblack – were decorated with paintings in the fresco technique of saints and scenes from the New Testament, that the paintings appeared to be entirely undamaged and that their colours had lost none of their freshness.

After submitting a report to the Directorate General for Cultural and Natural Properties, I was assigned, in January 1991, through a process of bidding, the task of exposing the wall paintings in one section of the church of Kalekilise and executing conservation measures.

SITE OF CHURCH AND ITS CONDITION

The church of Kalekilise near the underground city consists of two adjacent structures, each carved out of the tuff rock at a different time and in a different style. The original entrance of each structure has been obliterated by fallen rock. The entrances that now exist were subsequently created in random fashion.

One of the structures has a high central dome; the other possesses an apse and two vaulted naves, side by side, which are connected by archways.

The entire extent of the floor within the naves has been given over to numerous shallow graves and, here and there, feed troughs (colloquially *taka*) had been carved into the walls at some point in time subsequent to the original construction. Some portions of the walls, at a height ranging from 1-1.5 m, have suffered loss of integrity and become crumbly and eroded due to moisture. Further, two chambers were also subsequently annexed.

Apart from the presence of abrasion and flaking, the thick layer of soot covering the paint layer caused the mural paintings to survive in good condition until the present.

CONDITION OF THE WALL PAINTINGS

Soot produced as a by-product of lamps lighted for illumination has completely covered the painting surfaces. The thickness of this lampblack layer increases from the floor to the ceiling.

Due to the effect of the heat produced by the constantly burning lamps, the layer of lampblack in the upper reaches of the wall had separated away from the surface in the form of a thick crust.

Loss of painted surface had occurred in places where deterioration of the rock face took place due to moisture seepage from fissures because of capillary rise of water from the floor to the ceiling and where several channels had formed.

Painted plaster had fallen in areas where crevices had been produced through movement of the rock mass.

Painted surfaces had also disappeared due to excavation of the walls for feed troughs when this space was used at various periods as a granary and animal shelter and for the creation of passageways. In addition, painted plaster from lower portions of the walls had fallen as the result of concussions when this space was utilized for storage.

Damage perpetrated in recent years by treasure hunters was also visible. When the church was originally excavated, niches were cut into the walls, prior to the creation of the paintings, and stones bearing the sign of the cross were set within them. When, at a later period, the wall paintings were planned, these niches were closed off by the plaster on which the paintings were executed. Treasure hunters, hoping to retrieve objects of value from these recesses, had broken through the plaster and spoiled the paintings in these areas.

TECHNIQUE OF EXECUTION OF THE WALL PAINTINGS

Rendering, composed of a mixture of lime, tuff dust and straw is in two layers. It varies between 2-4 mm in thickness. The paintings were done while the plaster was wet. The overlapping of the *giornata*[1] is distinctly clear.

CONSERVATION TREATMENTS

Consolidation

The areas surrounding lacunae produced by the fall of plaster that no longer adhered to the rock face for a variety of reasons, and painted plaster threatening to come loose and break off, were reinforced by injections of *TB 1 Ledan.*[2]

Cleaning

PHASE 1

Dust and lampblack amenable to removal by water were cleaned by wiping with a damp sponge. In the process, the painted plaster became saturated to some extent. Consequently, when the chemical solutions were later applied to the surface to loosen the lampblack deposit, this absorption of water prevented excessive penetration of the chemicals into the plaster.

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1 *Giornata*: plaster prepared fresh for each day's use.

2 A mixture of commercial hydraulic lime and volcanic dust. It was mixed in the proportion of 200 g *Ledan* to 800 ml water.

PHASE 2

A solution of 15% ammonium bicarbonate was applied onto the surface through Japanese tissue paper and left for several hours; however, this produced no effect whatsoever on the lampblack deposit.

PHASE 3

A solution of 20 g EDTA[3] and 40 g ammonium bicarbonate in 200 ml water was next applied over Japanese tissue paper to the surface of lampblack layer. It was observed that though at first it had a dissolving effect on the deposit, the reaction soon dissipated. It became evident that, due to the heaviness of the deposit, this same procedure would have to be repeated a great number of times. The Japanese tissue paper failed to ensure that the solution spread over the surface would remain moist for the duration of the period needed for the grime and lampblack deposit to loosen.

PHASE 4

Clearly, it would be necessary to apply the solvent in a thick layer onto the surface and to keep it moist in order to secure continuation of the reaction process. With this in mind, the procedure below was used:

To a liquid solution composed of 10 l water and 200 g C.M.C.,[4] 50 g ammonium bicarbonate and 25 g EDTA were added, which was then applied through Japanese tissue paper. The area was then covered with a sheet of plastic. The cleaning reaction began to work immediately, softening the lampblack. Because the tissue paper proved impermeable to the gaseous solution produced during the reaction process, however, bubbles formed between the surface and the tissue paper. While in the surrounding areas the lampblack was removed down to the layer of paint, in the places where the solvent had produced bubbles, lampblack debris remained in the form of small blotches and lines. In the course of a repetition of this procedure to eliminate the extensive presence of lampblack traces, it became evident that the already cleansed portions were undergoing degradation. This procedure was therefore abandoned.

PHASE 5

The quantity of C.M.C. was increased to 50 g to improve the viscosity of the solvent, so as to keep it from invading cleansed areas. 200 ml of the prepared liquid (10 l water + 250 g C.M.C.) was mixed with 50 g ammonium bicarbonate and 25 g EDTA and directly – without the use of tissue paper – applied to the surface in a layer 3-4 mm thick. It was then covered with a plastic sheet, and left in place until the figures became visible – from 4 hours for light deposits and up to 15 hours for heavy deposits.

PHASE 6

A solution of 200 ml water + 50 g ammonium bicarbonate + 25 g EDTA (i.e., without the C.M.C.) was applied over tissue paper to the layer of lampblack over the now-distinct figures and repeated until they were entirely free of the deposit.

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3 Disodium salt

4 Carboxy methyl cellulose

PHASE 7

Elimination of any possible remaining traces of the solution and C.M.C. was carried out by a final cleaning operation, involving wiping the surface several times through tissue paper using a sponge moistened with lukewarm water.

CONSOLIDATION OF THE RENDERING AND FILLING OF THE LACUNAE

The deep lacunae formed on the rock surface after the loss of the painted plaster were filled to the original surface level with a mixture of 2 parts tuff powder to 1 part *hisir*[5] and ½ part slaked lime.[6]

To prevent the collection of dust and the nesting of animals, the two feed troughs, or *taka*, and the niche that was carved out in the original structure, were filled with stone coursework and plastered over with lime mortar (slaked lime and sand) to the level of the rock face.

The doorway that was cut into the apse to allow for passage to the other church and the one that led from the church to the subsequently annexed chamber were both closed off by stone courses to reduce the number of entrances to the church to only one.

PRESENTATION AND FINISHING TOUCHES

Loss areas in the layers of painted plaster were retouched with watercolours. The floor littered with graves was filled to the original level with *hisir*.

The window in the exterior wall, which was created at an early period in the history of the church but subsequent to the partial destruction suffered by the building, was covered over with canvas to eliminate the negative effects of dust and sunlight on the paintings and to close off the ruined portion.

Because access to the church would be difficult to regulate in view of the separate entrance to each of the two churches, an entrance of stone coursework was added to permit control over access.

A portable hand-held lamp was preferred over permanent fixtures for illumination of the church.

Finally, after restoration work, the church which had once been in a ruined state and open to access by one and all, could now be visited under the supervision of a guide hired by the Municipality and, when closed, secured by a locked iron door.

5 Pozzuolana sand called *hisir* by the locals of the region.

6 Slaked lime aged for 26 years.

CONCLUSION

Bringing to light the paintings in the churches in this area will add to the historical richness of Cappadocia, and Tatlarin will also be counted among sites of importance in this region.

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THE ICCROM PROJECT FOR CONSERVATION OF MURAL PAINTINGS IN THE ROCK CHURCHES OF THE GÖREME VALLEY (1971-1983)

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ABSTRACT

The conservation of the mural paintings of the Byzantine Church of Tokalı Kilise began in 1973 as a collaborative effort between the Turkish Government and the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), Rome. Today the work in Tokalı Kilise has been completed; the church was re-opened to the public in the fall of 1980 and a qualified team of young Turkish professionals has been developed, with a yearly programme of emergency intervention and preventive maintenance in operation for more than ten years. The paper discusses the history, goal and accomplishments of the project, as well as:

a) Overall conservation problems encountered.

b) Specific mural painting conservation problems and the causes of deterioration, including: detachment of plaster; scaling or friability of the pigment-bearing layer; humidity and humidity-related phenomena; vibration; and vandalism.

c) Geology of the region and the technique for the excavation of the churches.

d) Technique of the paintings, including pigment identification and information regarding the composition of the plaster and medium.

e) Conservation treatments, including consolidation, fixation, cleaning, and re-integration.

f) Discussion of a plan for the improvement of the general conservation environment and continued maintenance, including control of infiltrating rainwater, elimination of agricultural activities, weeds and wild trees from the immediate vicinity of painted churches, and control of tourist activities to avoid voluntary or involuntary damage to paintings and architectural details.

The Safeguard of the Rock-Hewn Churches of the Göreme Valley. Proceedings of an International Seminar. Ürgüp, Cappadocia, Turkey, 5-10 September 1993.

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ICCROM'S CONSERVATION EFFORTS AT GÖREME

The formation of a Turkish mural paintings conservation team commenced in 1973 at the Byzantine church of Tokalı Kilise, following a request for assistance delivered by the Turkish Government at the 1971 General Assembly the Rome-based International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM).

The mural painting component of the overall project had two goals:

a) to train and equip a local team of Turkish specialists who, through a continuing programme of preventive maintenance and emergency consolidative treatments, would ensure the survival of mural painting ensembles in the entire Göreme area, and

b) to conserve and restore one of the numerous painted early Byzantine churches in the Göreme area as an example for future preservation efforts.

Today these initial goals have been realized. Tokalı Kilise, the monument chosen as the didactic worksite, has been completed and the church was re-opened to the public in the autumn of 1980. Numerous Turkish professionals have participated in the project and have been trained in wall painting conservation theory and technique. They have also participated in a yearly programme of emergency intervention and preventive maintenance. During this time the church of Karanlık Kilise has also been treated.[1] This paper will describe the background of the project, and the work done at Tokalı Kilise and Göreme between 1977 and 1983, when the author was the ICCROM coordinator for this project.

Background of the project

In 1972, a "Preliminary Programme for the Conservation of the Rock Churches in the Göreme Area" was formulated by ICCROM.[2] Initially, the overall conservation problems were understood to be four:

- structural stabilization;
- conservation of the mural paintings;
- weathering of stone; and
- maintenance and tourist-related damage.

The structural considerations and the conservation of the mural paintings were considered to be the main priorities, and therefore received most of ICCROM's attention.

Structural conservation

The initial programme envisaged a comprehensive structural study to be undertaken by one of the large firms specializing in geological engineering. A preliminary study was sponsored by UNESCO, and carried out in 1974 by experts of the French firm of Soletanche.[3]

Although at the time a complete study of the geological formation was not available, a first examination of the area led Soletanche to the conclusion that the cracks were an ever-present feature of the tuff bank, and that carving out portions of the rock intensified their creation, as cracks appear to concentrate around hollow areas, corners of doors and windows, etc. Spalling of the rock and collapse of structures has occurred frequently, as witnessed by the profusion of partly destroyed halls, chapels and churches that are to be seen in the area. The cracks have a dual deleterious action on the churches, as they allow entry of water and thereby contribute to deterioration of the mural paintings, in addition to weakening the resistance of the structure to the mechanical stresses which originate in response to the wide variations of temperature and the freeze-thaw cycle prevalent in central Anatolia.

Unfortunately, the problem of the cracks is not likely to be solved by conventional techniques and requires careful study by engineering and geological experts. The following factors complicate successful conservation interventions:

- The size of the mass of rock. In some cases (such as Mary Chapel, Karanlık) the problem is equivalent to stabilization of a fair-sized mountain.
- The danger of using normal cement in the proximity of mural paintings, because of the soluble salts usually present.
- The difficulty of access to the churches.
- The need to respect the surrounding landscape (construction of roads, barracks, scaffolding, etc.), as it will impose serious limitations. Proposals put forward by consulting engineers will have to be carefully screened by architectural, landscaping and mural painting experts to ensure compatibility with the aesthetic and historic ambience of the monuments and of the area as a whole.

Included in the report was a general assessment of the site, and a more detailed analysis of some churches: Maryemana, El Nazar, Saklı, Tokalı, Elmalı and St Barbara. The report maintained that in order to produce a general hydro-geological plan of the area and detailed plans of consolidation for each rock structure, it would be necessary to carry out an extensive and extremely costly series of highly detailed studies. The studies would include topographical surveys, photogrammetry, climatological studies, continuous measurements of rock movement, sampling *in situ*, tests of consolidation methods *in situ*, laboratory studies, etc. Unfortunately, in 1974, the complexity of the structural problems, combined with the high estimated cost of the studies and the lack of available funding, all contributed to preventing until 1982 any further progress on this aspect of the work.[4]

Conservation of mural paintings

Normally one refrains from any conservation of mural paintings until all structural problems have been solved, because most of the agents of deterioration affecting mural paintings can be traced to flaws in their housing structures. But at Göreme the situation was desperate and emergency stabilization of mural paintings was urgently required in many churches. In addition, at Göreme, it must be kept in mind that prior to the enactment of any structural engineering work, the mural paintings existing inside the monument would have to be protected against contact with grouts, vibration, and accidental contact, etc. This protection could include consolidation and fixation and possibly the application of protective facings to the painted surfaces.

For the above reasons and the fact that the formation of a local team of experienced technicians would require several years, it was considered necessary to begin the training immediately. Moreover, since the funding for the mural painting conservation component was minuscule in comparison to that required for the structural studies, the funding was secured and half of the initial project went forward.

The training of the local mural paintings team was realized on the spot by means of international campaigns of emergency consolidation and training. There is now a sizable pool of Turkish conservators and conservation technicians with wall painting conservation experience gained at Göreme and at ICCROM courses and internships. With proper organization, funding, and local and international support, this "team" is capable of continuing the work independently and is available to protect the mural paintings during any forthcoming large-scale structural interventions.

Beginning in 1973, successive missions of some 50 days each were made by teams from ICCROM working with the then young Turkish conservator-restorers, who therefore were able to expand greatly their professional experience. Tokalı Kilise was selected as the pilot monument because of the dangerous condition of the mural paintings and the absence of any major structural problems.

TOKALI KILISE

The state of preservation

A comparison between the photographs reproduced in *Les églises rupestres de Cappadoce* [published between 1925 and 1942] and the state of the church in 1973 clearly allows one to see that deterioration has advanced at a rapid rate in modern times.[5] The main problems of conservation that were found at Tokalı Kilise were:

- detachment of plaster;
- friability and scaling of the pigment-bearing layer; and
- damage caused by vandalism.

Detachment of plaster. Large areas of detached plaster were located at Tokali Kilise by listening to the different sonorities produced by tapping with the conservators' knuckles and then visually observing the vibration that was provoked. These were present, above all, along the borders and the corners of the niches and the joints between the various applications of plaster (Figures 1 and 2). Detachment is caused by a loss of adhesion between strata, often due to expansion and contraction of heterogenous components in the plaster (especially the organic materials) in response to variations in temperature and relative humidity. Loss of adhesion can also result from the action of plant roots, animals or insects, micro-organisms, crystal growth, vibration, etc.

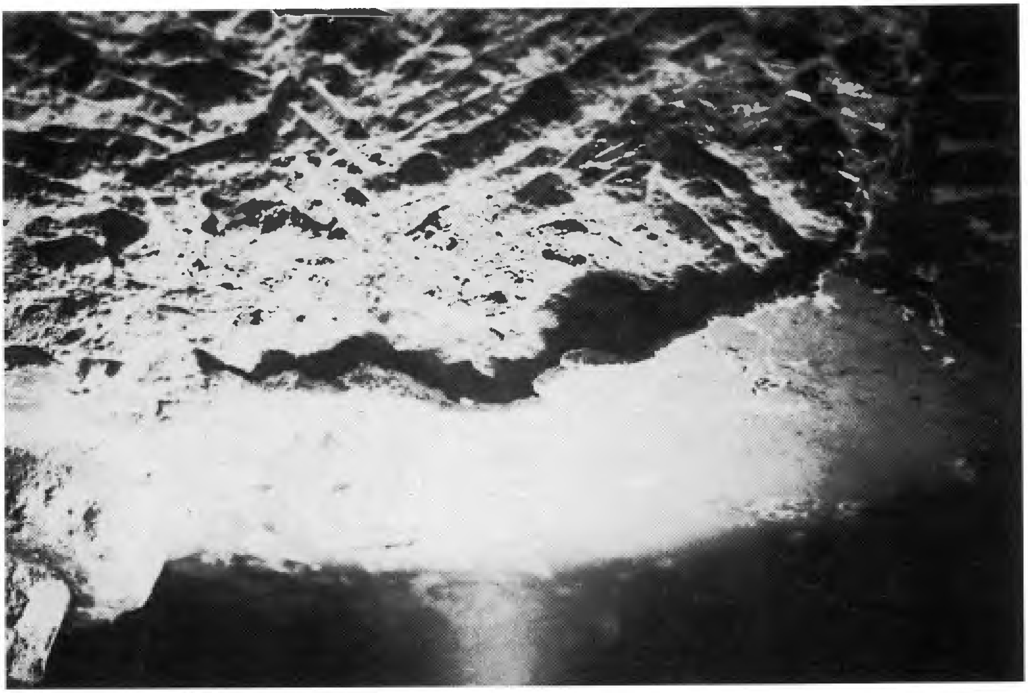

Figure 1. Tokalı Kilise, detail of detached plaster.

Figure 2. Tokalı Kilise, detail of detached plaster.

In the case of Tokalı Kilise, humidity and humidity-related phenomena, along with vibration, would seem to be the agents most likely responsible for the detachment of the plaster.

Humidity. Humidity can enter the church by diverse means:

- *Infiltration* of water channelled through the cracks which are a normal phenomenon in this type of geological formation. The cracks are affected adversely by the volumetric changes during freeze-thaw cycles. In addition, at Tokalı there was cultivated terrain directly behind and above the church, which undoubtedly contributed to the infiltration of water.
- *Condensation.* The very high RH and low temperatures at night in certain periods of the year, as recorded on the thermo-hygrometer charts, makes the occurrence of condensation on the walls probable.
- *Capillarity.* At the base of the southeast wall, water has risen to a height of almost 3 m through capillary action. In this zone, the tuff is very porous, almost sandy in appearance, and has little cohesive strength.

Vibration. Tokalı Kilise is situated alongside the main road from Ürgüp to Avanos which passes through Göreme. Very large trucks and tourist buses continually traverse this road, often at great speed. The vibrations that result were easily felt by the restorers working in the church. Recent research has linked certain frequencies of vibration to detachment of mural painting plasters, a process very likely in action at Tokalı Kilise.[6]

Friability and scaling. Friability is due to the loss of cohesion within the pigment-bearing layer (Figures 3 and 4). Scaling, on the other hand, is due to the loss of adhesion between strata. Two factors are probably at work:

- microbiological attack or deterioration provoked by exposure to light on any organic binders originally used.
- cycles of exposure to periods of high relative humidity with concurrent volumetric changes.

Vandalism. Vandalism has greatly contributed to the degradation of Tokalı Kilise and most of the other churches at Göreme. There are extensive lacunae and losses as a result of mechanical shock and vibration produced by the impact of projectiles (rocks, clods of mud, bullets, etc.). In addition, there are incisions of graffiti, abrasions and scrapings, particularly on the faces and on the figures (Figure 5).

Physical characteristics

Techniques of execution. Excavated from volcanic tuff, the church was first decorated with bands, crosses and geometric decoration which accentuated the architectural elements. These were painted with red and green earths directly on the rock at the time of the consecration of the church.

In the main church the rock walls were then prepared with a render or *intonaco* (2 to 8 mm in thickness) composed of lime charged with straw. This render was applied in registers or *pontate* which in general conform to levels of scaffolding. On the intonaco a priming layer of lime whitewash was applied. In the narthex, by contrast,

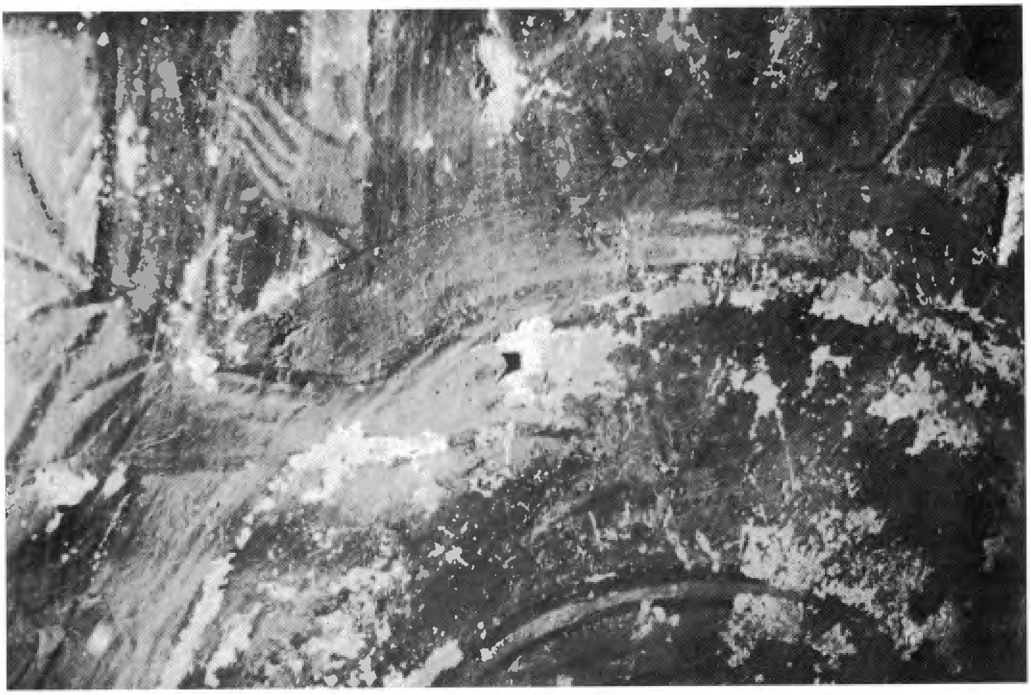

Figure 3. Tokalı Kilise, detail of scaling paint layer.

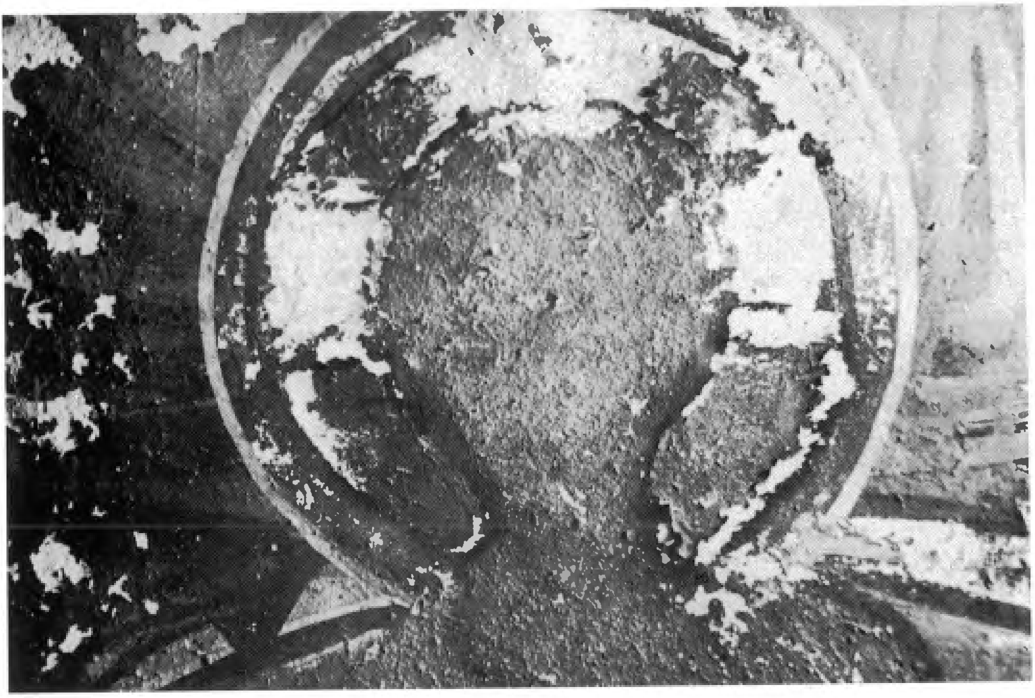

Figure 4. Tokalı Kilise, detail of scaling paint layer.

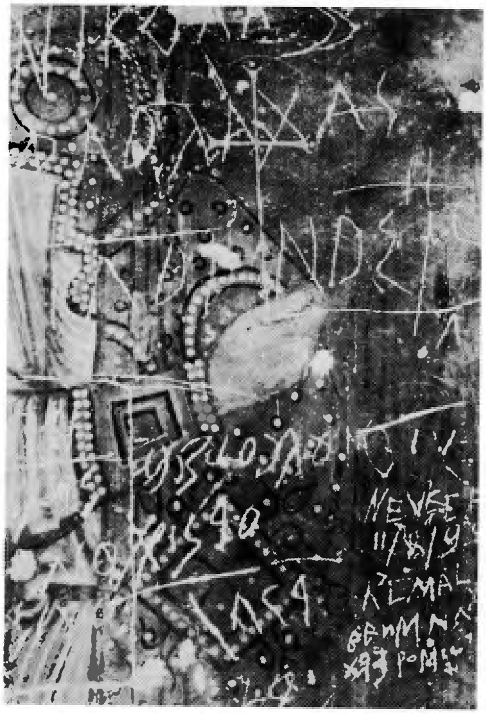

Figure 5.
Tokalı Kilise, detail of graffiti.

a very thin priming layer was applied directly on the rock and no true *intonaco* is present. There are traces of a preparatory drawing in red ochre on the whitewash priming.

Red ochre, yellow ochre, green and other natural earths, carbon black, gypsum white and lapis lazuli have been identified as the pigments used.[7] Highlights are done with gypsum white. Although most halos were painted with a simple base coat of yellow ochre, traces of metal leaf (gold and silver) are seen on the halos of Christ. The pigments were applied on the dry plaster using a proteinaceous material as the binder, possibly casein.[8]

Conservation treatments

All conservation treatments undertaken were those advocated at the time by the Istituto Centrale del Restauro, Rome. These interventions were perfected and demonstrated during the first years of the missions to Göreme by Prof. and Mrs Paolo Mora, Chief Restorers of the Istituto, who launched the project and supervised the initial test treatments, and later by Miss Isabelle Dangas, who was, in effect, the *chef de chantier* from 1977-1990.

Consolidation of detached plaster. The ICCROM team concentrated on the problems of the detached and unstable plaster preparation of the mural paintings because of the immediate threat of further loss. Plaster was re-attached by injecting a mixture of calcium caseinate, lime and casein, with an admixture of 10% polyvinyl acetate

Figure 6. Tokalı Kilise, reattachment of loose plaster.

emulsion.[9] Smaller areas of detachment were injected with either polyvinyl acetate emulsion diluted from 30-60% with water, or *Primal AC 33* diluted 20% in water[10] (Figure 6).

The area to be re-attached is first thoroughly cleaned of dust and loose particles through the use of an aspirating bulb. The area is pre-wet with a mixture of alcohol and water, and then the consolidating agent is injected using syringes with either a hypodermic needle or a plastic tube. Where possible, the injection is done through an existing damage in the painting. After introduction of the adhesive the detached area is pressed back in contact with the wall by means of one or more cushioned wooden palettes until the consolidant has set.

Fixation of the paint layer, scaling and cupping. Flakes were softened and pressed back into place by tamponing with water and a sponge through a layer of Japanese tissue paper. The scales were re-attached by either the application of a solution *Paraloid B 72* (5-7% in lacquer thinner) or an emulsion, *Primal AC 33* (12% in water). After the resin is applied with a brush and has partially dried and become tacky, the scale is pressed back into place with a spatula. During this operation, a sheet of plastic is used as a buffer to avoid burnishing the surface.

Cleaning. No trace of previous restorations was observed at Tokalı Kilise. Thus, the surface accumulations found do not include retouchings. A general deposit of candle smoke coats most of the paintings in Tokali Kilise. A very thick concentration of wax was observed on the lower part of the ikonostasis. Dust, mud, bird excrement, insects and lead pencil and charcoal inscriptions were also encountered.

The cleaning was a very delicate process because of the fragile nature and condition of the paint layer. In the course of the cleaning a variety of methods were used, depending on the substance to be removed. Dust was removed with a soft brush, gum eraser or special silicone sponges,[11] depending on the resistance of the paint film. Graffiti in lead and charcoal were also removed with a gum eraser. Where the dust was more firmly attached, water was applied by brush through Japanese tissue or by tamponing with a sponge. Delicate areas were cleaned with fine, soft brushes, water and patience.

Mud and organic deposits were initially removed mechanically. The final traces were cleaned with a solution of 10% ammonium hydroxide in water. The thick layer of wax found on the lower ikonostasis – in some areas more than a centimetre thick – was mechanically reduced to a thin layer and then the residual stratum was removed with organic solvents.

To remove the stubbornly attached candle smoke and fatty matter complex that one found almost everywhere in the main church, a variety of agents were used, sometimes in combination. These ranged from mixtures of water, alcohol and acetone, to diluted butylamine or solutions of sodium bicarbonate (Figures 7 and 8)

The entire church, excluding the narthex, was cleaned according to the following procedure. A saturated solution of sodium bicarbonate in water was applied with a

Figure 7. Tokalı Kilise, detail of *Peter Ordaining the Deacons*, during cleaning.

Figure 8. Tokalı Kilise, detail during cleaning.

brush through tissue paper. It was left in place for a period of approximately 30 seconds; the time varied with the specific location and pigment. When the appropriate time had elapsed, the surface was moistened with a damp sponge and the paper compress was removed. The dirt, now dissolved, was removed by tamponing delicately with a moist cotton pad. If further cleaning was necessary, a weak solution of butylamine in water (5%) was employed. The surface was then thoroughly rinsed with water. Any residues of the reagents were absorbed into paper compresses.

Where the layer of dirt had been fixed by a previous application of *Paraloid*, it was necessary to eliminate the resin on the surface by tamponing with lacquer thinner and successively eliminating the layers of dirt and smoke with saturated solutions of sodium bicarbonate in water.[12] Because of the toxicity of the solvents, masks equipped with organic vapour absorbing filters were necessary.

Lacunae and re-integration. The numerous lacunae that one found at Tokalı Kilise seriously disturbed the legibility of the paintings. Following the methodology of re-integration of the Istituto Centrale del Restauro, *acqua sporca* (thin transparent washes of watercolours of a slightly lighter but similar tone) was applied to the lacunae to correct visual disturbances caused by the sharp contrasts between the light plaster preparation exposed by losses, and the darker pictorial layers[13] (Figures 9 and 10).

Completed sections received a final protecting fixation of 3% *Paraloid B 72* in lacquer thinner.

Figure 9. Tokalı Kilise, conch of the prothesis apse before treatment.

Figure 10. Tokalı Kilise, conch of the prothesis apse, detail of the angel of the south.

Emergency structural interventions

Although the frescos of Tokalı Kilise have been the object of extensive consolidation measures, detachment will continue until the underlying causes have been eradicated or controlled. To this end, during the conservation campaigns prior to the re-opening of the church, several steps were taken to improve the general conservation environment of the church.

Infiltration of dispersed rainwater. During particularly heavy rains in late September, 1978, infiltrations of water were observed in the northwest corner of the vault of the narthex and along the interior of the arched entrance to the church. Two emergency interventions were implemented to arrest the entrance of water into the church.

a) To drain water away from the painted areas, a small temporary conduit was inserted into a major crack in the northwest corner of the narthex. The conduit was fixed in place with a stucco of hydraulic lime and tuff dust.

b) The exterior of Tokalı Kilise was thoroughly examined in order to locate the fissures in the rock through which the rain water had entered the church. These were sealed with applications of bitumen covered with a layer of lime and tuff dust.

Vibration. Although the problem of vibration is a complex one in terms of Tokalı Kilise, the road that passes in front of the church must be repaved to be as smooth and regular as possible to reduce the vibrations.

Adjacent cultivated land. The cultivation of the terrain in proximity to Tokalı Kilise was stopped. The land was purchased by the Turkish government but the agricultural activity still persisted and thus the dangers to the church that this activity posed – deep-rooted plants, churning up the soil, imprudent irrigation, salts from fertilizers, etc. – had not been eliminated.

Present situation and recommendations

Although during the project many simple and effective interventions were carried out for the preservation of the churches by the local authorities, the problems are enormous and many more maintenance works of a continuing nature are required, including:

- control of dispersed rainwater[14]
- examination of cracks and of water infiltration
- elimination of agricultural activities and in general of all weeds and wild trees from the immediate vicinity of painted churches. Particular care must be taken to ensure that water passing through agricultural soil is not allowed to reach the painted surfaces through porous stone or cracks. Detachment of plaster from walls has been attributed to bacterial activity or to soluble salts; both are present in water filtering through soil rich in vegetal matter.
- control of tourist activities to avoid voluntary or involuntary damage to paintings and fine structural details, including tourist-related erosion.

Perhaps most important of all, the future survival of the churches and their paintings in the whole of the Göreme Valley will depend upon the establishment of an adequate on-site infrastructure and a constant adherence to a satisfactory code of maintenance for the churches and the site in terms of the regulation of tourist activities.

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END NOTES

1. Over the years, many conservation professionals have contributed to the project. Special recognition is due to:
   - Cevat Erder, of METU, and formerly Director of ICCROM, who was instrumental at all levels in the success of the project.
   - Prof. and Mrs Paolo Mora, Chief Restorers of the Istituto Centrale del Restauro, Rome, who initiated the work and supervised the initial tests.
   - Revza Ozil and Ridvan Isler, the veterans of the Göreme Team.
   - Isabelle Dangas, France; *Chef du Chantier* for Tokali and Karanlik Kilise from 1977-1990.
2. Torraca, 1972.
3. Messrs. Granier and Isnard.
4. UNESCO, in 1982, announced and proceeded to implement an international campaign for the preservation of the rock-cut churches of the Göreme Valley. As part of this project, ICCROM received a contract to set specifications for the consolidation of the structures. As a first step in the resolution of this problem, a preliminary mission of ICCROM consultants, under UNESCO Contract, inspected the site in October 1982: see "ICCROM Mission for the UNESCO/UNDP Project for the Structural Conservation of Göreme", ICCROM, Rome, 1983; including: "Hydrogeological Aspects," Bowen, R.; "Static and Civil Engineering Aspects," Lizzi, F.; "Architectural Aspects," Verité, J.
5. de Jerphanion, 1925-1942.
6. Stevens, 1974.
7. Lapis lazuli was the rarest and most expensive pigment of ancient times. Its extensive use here, in all the blues, is an indication of the importance of these paintings.
8. Samples from Tokalı Kilise were analyzed by the laboratories of the Istituto Centrale del Restauro, Rome; and the Monuments Historiques, Champs sur Marne, France. The laboratory of the Monuments Historiques identified the presence of casein by infrared spectrophotometry and microchemical analysis.
9. Lime caseinate is the traditional adhesive used by wall painting conservators for re-attaching loose plaster. Research conducted in the early 1980s by Torraca *et al.* (1984) led to the use of a low-alkali hydraulic lime (*Chaux Blanche*, manufactured by Lafarge, France) for this purpose.
10. *Primal AC 33* is an emulsion of *Paraloid B-72* – an acrylic resin co-polymer of acrylates and methacrylates – produced by the Rohm and Haas Company.

11. Wishab Sponges, Akachemie Albert Kanderer, Wilheim, FRG.
12. The composition of commercial lacquer thinners varies. A typical thinner distributed in Italy under the trade name *Diluente Nitro* contains ethyl acetate 15%; butyl acetate 15%; cellosolve acetate 2%; normal butyl alcohol 6%; and toluol 62%.
13. The watercolours used are the Artists Quality Series produced by Winsor and Newton, London. The palette of specific pigments has been chosen for their stability and resistance to light.
    See Appendix V, 7, p. 413 in Mora, Mora and Philippot, 1972.
14. See Giantomassi *et al.*, in press; and Massari, 1978.

21

RECOMMENDATIONS

INTRODUCTION

The Göreme Valley, with its rock-hewn churches and urban settlements, is among the most important sites of Byzantine art and culture, whose importance is stressed by its inclusion in the UNESCO World Heritage List.

The problems of conservation of paintings, structures and landscape and those related to site management have been extensively studied by many experts over the last two decades.

The international seminar held in Göreme (5-10 September 1993) was a forum for an in-depth, critical discussion, among those experts, on the results already achieved.

It was also an occasion for a fruitful exchange of opinions with other participants, who contributed their own expertise on similar conservation problems. To that purpose, some site visits and inspections allowed a direct understanding of the current situation and provided a useful comparison with the results envisaged by the previous studies, field trials and conservation treatments.

Four Working Groups were established by the seminar coordinators to discuss the main issues of the Göreme conservation problem:

Working Group Nº 1	Site Management and Heritage Tourism
Working Group Nº 2	Material Analysis/Conservation
Working Group Nº 3	Structural Stabilization
Working Group Nº 4	Mural Painting Conservation.

WORKING GROUPS

The membership of the working groups was as follows:

Working Group Nº 1 – Site Management and Heritage Tourism

Gül ASATEKIN
Osman BURAT
Jukka JOKILEHTO *(Chair)*
Emre MADRAN
Alessandra MELUCCO
Paul M. SCHWARTZBAUM
M. Kirby TALLEY
Nicole THIERRY DE CRUSSOL
Leo VAN NISPEN
Jonathan WAGER
Said ZULFICAR

Observers:

T. Sermin ERDEM
Ülkü IZMIRLIGIL

Working Group Nº 2 – Material Analysis/Conservation

Emine CANER SALTIK
Eddy DE WITTE
Marisa LAURENZI TABASSO *(Chair)*
Lorenzo LAZZARINI
Tamer TOPAL

Observers:

Ülkü IZMIRLIGIL
Mehmet OCAKÇI
Ismet OK
Aylin ÖNEY

Working Group Nº 3 – Structural Stabilization

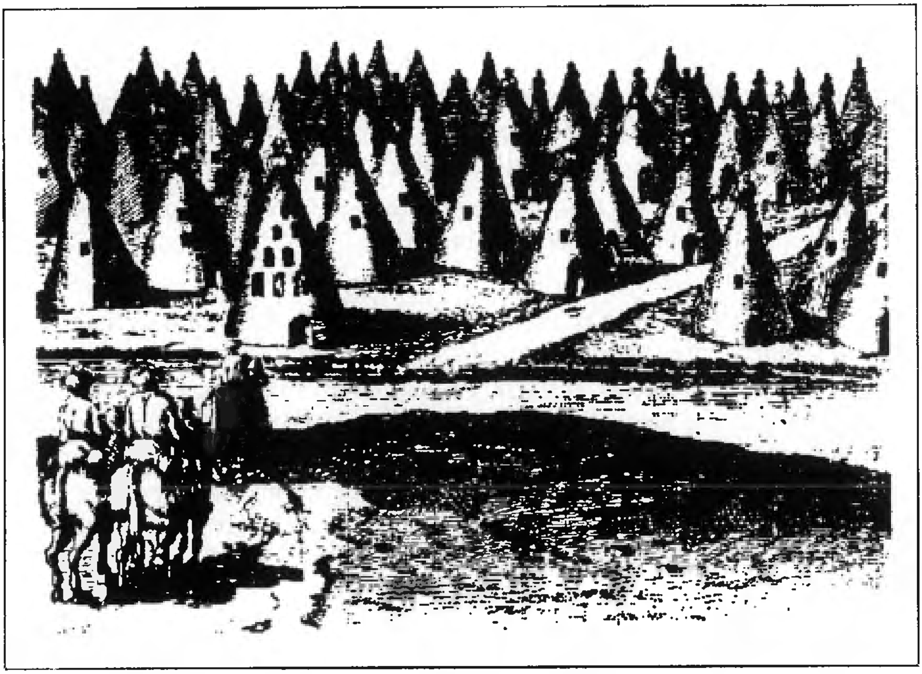
Zeynep AHUNBAY
Osman BURAT
Ali Cetin IDIL
Pier Paolo ROSSI
Martin E. WEAVER *(Chair)*

Working Group Nº 4 – Mural Painting Conservation

Isabelle DANGAS
Ridvan ISLER
Revza OZIL *(Chair)*
Werner SCHMID

Observers:

Fazil AÇIKGÖZ
Gülseren DIKILITAS
Nurhayet DURAN
Buket GÜRELI



PROPOSALS FROM THE WORKING GROUPS

The four Working Groups were requested to discuss their specific topics, giving at first an evaluation of the present situation as observed in the study visits carried out during the seminar. They were also asked to propose future actions, indicating priorities and, so far as possible, also suggesting who should undertake them.

Group № 1, Site Management and Heritage Tourism, prepared a general report including short- and long-term projects for the preservation of monuments and maintenance of sites. In contrast, Groups № 2, 3 and 4 dealt with the technical reports on material analysis/conservation, structural stabilization, and mural painting conservation that must be carried out jointly by an interdisciplinary team.

Although the time for discussion was insufficient for in-depth discussion on all the complicated problems raised by the Göreme seminar, the working groups stressed the importance of the following major issues:

- the need for coordination among the different authorities responsible for the region in order to assure that the proposed law for the Preservation and Development of the Cappadocia Region can be successfully implemented;
- the urgent need for Tourism Management which provides viable solutions to the problem of the conservation of monuments and of the whole cultural landscape;
- the extremely urgent need for provisions to prevent further damage and further losses, at least in the most important monuments. Emergency stabilization and small-scale treatments must be carried out jointly by a team of structural technicians and mural painting conservators. First aid interventions should start from the already restored churches;
- the urgent need to create a team of resident local experts that are capable, if required, of carrying out the necessary inventory survey, monitoring and maintenance. This team must be supported by establishing a Permanent Scientific Laboratory with basic equipment sufficient to meet the needs of the site; and
- an Interdisciplinary Site Committee of international and national experts must be formed and should meet on a regular basis.

A further point must be made. The safeguard and conservation of this heritage cannot be assured by independent actions trying to solve specific, even if urgent, problems. Monuments, natural landscape, resident population and visitors are all partners in determining the cultural landscape. Solutions considered suitable for the problems posed by each of those partners should be selected and adopted with due consideration of the impact on the other partners. That does not mean, however, that suitable solutions can be found only after years of expensive studies. On the contrary, useful action can be undertaken now, provided the necessary coordination is in place.

Proposal from Working Group Nº 1

SITE MANAGEMENT AND HERITAGE TOURISM

That the Cappadocia region has been listed as a World Heritage site is more than ample proof that the unique heritage importance of this area has been recognized by the specialized international conservation community. Such recognition, however, is not sufficient to guarantee the optimum protection and development which such a region requires if it is to retain its monuments, its topographic characteristics, and its daily life – what is referred to as its cultural landscape – in as pristine a condition as possible.

In order to implement the necessary protection and development, the following measures are recommended:

1) Considering the obvious lack of communication and co-ordination among the diverse parties responsible for the preservation of the Cappadocia region, the present proposal (the draft *Law for the Preservation and Development of the Cappadocia Region*) before the Turkish Parliament should be passed into law and implemented **with all due haste.**

2) During the past twenty years, many intrusions on the landscape have appeared. Unsightly hotels, parking lots, souvenir shops and the like to facilitate tourism now blot the Cappadocia region. It must be remembered that tourism is not a goal in itself, but merely a tool, an important tool for generating income, and providing pleasure at the same time. To do this in an optimum manner and on a long-term basis it is recommended that these unsympathetic intrusions be re-located and that a long-term policy be developed which respects the integrity of the Cappadocia region while at the same time providing the tourist industry with a quality product. The adaptive re-use of traditional housing stock in a sympathetic manner can play an important role in the proper exploitation of "typical" resources of the Cappadocia region. An evaluation of the traditional housing stock should be made at the earliest opportunity.

3 To implement proposal Nº 2, the tourist industry must be directly involved in the decision-making process, and its expertise must be coordinated with that of the conservation community. The support of the local community and its participation in this process is imperative. To achieve this, public awareness programmes will have to be amplified to raise further the level of public consciousness about the fragility of their environment.

4) Heritage management training programmes should be established to train those responsible – at various levels – in the basic aspects of managing cultural landscapes, developing long-term programmes for sustainable tourist growth, emphasizing integrated regional development which respects social and cultural values, implementing effective site management, providing various levels of tourist attractions and experiences within the Cappadocia region, fund-raising, and above all, in understanding and appreciating the complexities of preservation versus exploitation. This will make it possible to develop new

and meaningful strategies for sustainable tourism which will recognize and emphasize the relatively new concept of cultural landscape. In order to facilitate the exchange of information, it is suggested that a newsletter on the preservation of the Cappadocia region be considered. Such newsletters are an important management tool and can be beneficial to fund-raising efforts. Resource inventories to assist policy making and monitoring are also crucial for long-term planning.

5) With regard to structural stabilization, the basic research has already been carried out. Pending passage of the new law, projects must be undertaken **now** to preserve those major monuments which are in immediate danger of collapsing. These projects must be evaluated and guided by an interdisciplinary team. Beyond such projects, preservation can be greatly assisted by ensuring that systematic site inspections be carried out on a regular basis. For example, a man with a pail of mortar can do a great deal toward preventing water damage to monuments. This is a very simple treatment, but such maintenance must be implemented now and not tomorrow. Maintenance, both simple short-term action and long-term projects, is an essential element of site management.

Proposal from Working Group № 2

MATERIAL ANALYSIS/CONSERVATION

There is a need for a Coordination body for all actions, including monitoring and collection of all the available information.

Studies to be carried out include the following:

Tuff characterization (including of the hard pan):

- Inventory of the varieties of the Karak tuff and better investigation of their homogeneity.
- Study of tuff properties in respect to water, namely water absorption by capillarity, by total immersion, etc.; rate of water evaporation; water vapour permeability; liquid water permeability; and hydraulic dilatation coefficient.
- Study of resistance to abrasion and of hardness.
- Water soluble salts content (quality, quantity and distribution).
- Identification of lichens.

Effects of precipitation:

- Study of the water runoff.
- Measure rain and snow intensity on site.

- Monitoring of temperature and of water content and distribution inside the stone (possibly to be discussed with the Working Group on Structure).

Mural Paintings:

- Painting techniques: renderings, binders, pigments, etc.
- Causes of deterioration: salts analysis, micro-organisms, etc.

Conservation products:

- Studies on plasters and gap-filling materials (hydraulic properties of tuff and so forth).
- Evaluation of the tests on plasters and gap-fillings already carried out.
- Studies of strengthening and water-repellent products.

Institutions that could/should be involved:

- METU/Istanbul Laboratory (collaboration with IRPA, if necessary)
- METU and Meteorological Service (Ankara)
- Istanbul laboratory/METU (collaboration with IRPA; Venice University)
- on conservation products: ICCROM; METU; Istanbul Laboratory; Venice University; IRPA.

Conservation Actions:

Inventory/Survey of the Open Air Museum:

- Organization and setting up of a data bank of dated graphs, photographic and photogrammetric documentation in order to evaluate the rate of deterioration.
- Four-person teams, comprising an art historian, restorer, geologist, and expert on materials science. A reduced team of two could start the jobs (restorer + art historian). The team must be resident on site.

First-aid interventions (starting from the already restored churches, where necessary):

- Filling cracks.
- Improvement of water drainage.
- Design and setting up of provisional and seasonal repairs.
- A team consisting of two restorers, one chemist, one architect and two workers (perhaps from the former team active on mural paintings). The team should be resident. For the provisional repairs, a specialized company should be involved.

Site Management:

- Put asphalt on the road in front of the Topalı church so as to reduce the dust.
- Forbid coaches stopping in front of the church.
- Reduce the number of visitors inside the churches.

- Delimit allowed paths for visitors.
- Cover allowed paths with wooden structures (?) to reduce dust.
- Cover not-allowed paths with other materials (gravel?) to reduce dust.
- Impose speed limits near the Open Air Museum.

Conservation/maintenance

- Activities should be implemented in order of priority, according to the needs indicated by the survey:
- A resident team must be established to ensure continuous monitoring. The team must also be supported by a small scientific restoration laboratory.

Conservation of vernacular architecture:

- Inventory of problems affecting vernacular architecture.
- Preparation of guidelines for those involved in the repairs and maintenance operations.
- Awareness raising and training of those involved in the repairs and maintenance operations.

A resident team of at least three persons must be established, comprising one architect, one engineer and one expert on materials conservation.

The Turkish Ministry of Culture and the local Authorities must retain responsibility for the conservation activities. Other institutions and research centres (national and international) could contribute to the training of the local teams.

Fund raising:

- UNDP; World Heritage Fund; UNESCO; NATO; Dumbarton Oaks Foundation.

Proposal from Working Group Nº 3

STRUCTURAL STABILIZATION

The group was asked to prepare a statement on the present situation with regard to the structural stabilization of the rock of the cultural and natural properties of the Göreme region of Cappadocia.

After a brief discussion it was agreed that, apart from the very limited construction of some walls under the unstable slab of the floor of the El Nazar Church, there had been no structural stabilization of any of the wide range of rock masses and formations which have been utilized for churches, monasteries, homes and other purposes in the conservation region.

It was further agreed that, considering the very long period which has elapsed since the earliest conservation studies – at least since 1969 – this was remarkable, and that the delays had undoubtedly led to the loss of parts of some of the rock-hewn resources and to the threatened loss of parts of others.

The following points and recommendations may provide a series of useful courses for immediate and future action.

The Problems

The structural deterioration of rock masses containing cultural properties in this region has been defined in papers delivered at this seminar by Rossi and by Weaver.

It is recommended that all further investigation, analyses and testing procedures should be based upon or developed from the standard scientific procedures developed by the International Society for Rock Mechanics (ISRM).

Emergency Situation

The group has further reviewed the situation with our colleague, Osman Burat, and we have established the following list of the highest priority sites for stabilization. In order of priority these sites are:

1. The Elmalı - Saint Barbara Complex.
2. The Meryemana Church.
2. The Saklı Church.
3. The El Nazar Church.

In these cases, parts of the rock masses and slabs are at risk of imminent collapse, which could also lead to a loss of significant mural-painted surfaces.

Recommendation

It is recommended that an emergency mission team be commissioned as soon as possible to go into the field and study these four priority sites to design immediate structural stabilization measures. The studies would first design and locate emergency temporary support systems of bracing and shoring. The studies would go on to design permanent stabilization systems specifically for these monuments.

It is recommended that the full team should consist of the following:

For Structural Conservation:

Rock Mechanics Engineer, Rossi.

Architectural Conservator, Weaver.

Structural Engineer, Jokinen.

Structural Geologist, Erdogan.

For Coordination:

Conservation Specialist, Burat.

As Special advisor:

Mural paintings conservator.

The mission would probably consist of two initial phases:

Phase 1. – Site study

Emergency stabilization measures design; research and data collection for final stabilization/conservation design.
(Primarily site work)

Phase 2. – Development of final conservation design

(Primarily in the offices and laboratories of team members.)

These would hopefully be swiftly followed by:

Phase 3. – Implementation.

A Preliminary Project

While the first emergency mission is going ahead, the Elmalı - Saint Barbara complex might be the subject of a second project.

This complex is not only a high priority for stabilization but also appears to represent an example typifying well the problems of the rock-hewn monuments in general. With this in mind, the group recommends that this complex also be the subject of a pilot project, both for the development and perfection of techniques, and for the training of conservation personnel.

Highly specialized techniques can be developed and specialists and operatives can perfect approaches which can then be applied elsewhere in the conservation area.

Typical examples of operations which could be developed in this way include:

- the design and installation of "tent" and tension structures for the temporary protection of sites from rain and snow;
- rock wedge and fractured rock mass stabilization by rock anchor installation using grout injection anchors;
- additional low-pressure grouting operations;
- the design, installation and operation of crack monitoring devices, with an emphasis on simplicity, practicality and appropriate levels of accuracy, i.e., 10-100 microns;
- the design, modification, installation and dismantling of light-weight aluminium scaffolding systems of highly flexible design for rock stabilization applications, such as the *Ponteggi Dalmine* system from Bergamo, Italy, or an equally flexible system currently available in Turkey;
- the development of site control and management measures to avoid tourist erosion of the surfaces of sensitive rock masses, such as preventing further

public access to the rock dome over Elmalı because of the severe erosion problems now being caused; and

- the design, development and installation of water control measures. The group saw a number of measures which were relatively cheap and effective and had already been demonstrated on churches which had been conserved by the mural paintings conservation teams. Such simple methods would form the basis for the development of further and more sophisticated methods should the need be established.

Reviews

Detailed reviews should be undertaken immediately to establish what percentage of the essential studies recommended in earlier reports have actually been carried out. (See, for example, "Structural Conservation of Göreme. Project Findings and Recommendations." UNESCO, Paris, 1988.)

These studies should include:

- photogrammetric surveys and measured drawings;
- meteorological and environmental data on

    air temperatures;

    rock surface temperatures;

    rock mass temperatures at various depths;

    rainfall;

    snowfall;

    wind forces and directions;

    dust particle granulometry, masses and impact velocities;

    precise seismic risk analysis;

    biodeterioration factors, postulated and proven;
- rock material composition, petrography and chemistry for all types of the volcanic tuff;
- macro- and micro-geological data on rock formations;
- geo-structural surveys;
- surface erosion rates; and
- vegetation studies to determine natural species and types suitable for slope and surface stabilization to reverse the process of desertification and erosion.

On the basis of these reviews, further data collection and analyses would be recommended.

The emergency mission team would need to be aware of the data deriving from this process, but need not actually perform the studies.

Legal and Management Framework

A framework must be developed to ensure that an appropriate legal basis exists to facilitate rapid and timely implementation and management of rock stabilization measures to the highest scientific, technical and professional standards. The almost complete failure of the 1982 UNDP Structural Conservation of Göreme Project to secure any structural stabilization objectives, and the current state of the cultural properties listed above, underline the desperate urgency of this item! (See UNDP/UNESCO reports of Project TUR/79/012.)

Project Implementation and Conservation Process Management

Practical standards must be developed for the whole conservation process, possibly consisting of seven phases according to the following model, to be applied to all cultural properties in the region:

Phase 1. – Project identification:

- Each cultural property would be identified individually and a project dossier would be established for each. The project dossier is the equivalent of a patient's medical records. No such dossiers currently exist.

Phase 2. – Project Initial Study:

- geo-location (UTM coordinates, etc.);
- legal definition;
- brief description of the resource and its condition;
- priority stabilization and protection issues and related countermeasures and recommended actions; and
- maintenance recommendations and a preliminary maintenance plan.

Phase 3. – Research:

- Recording and surveying including photogrammetry, photography, measured drawings;
- macro- and micro-environmental data, including climatic and pollution data;
- historical research;
- art history and iconography;
- paintings' condition surveys;
- micro- and macro-geological research with petrographic analyses; and
- economic and social research, including regional planning and tourism development factors.

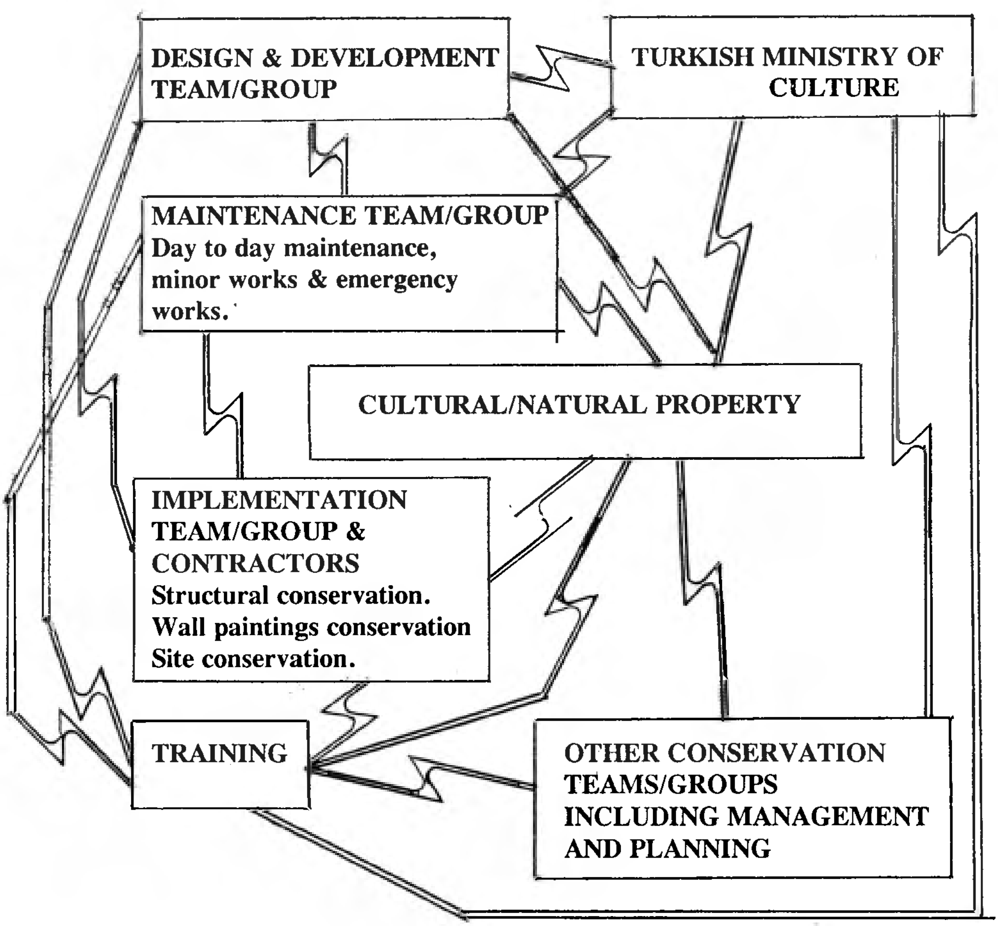
Phase 4. – Preliminary Design for conservation measures based on Phase 3.

Phase 5. – Final Conservation Design and presentation of Maintenance Plan, complete with drawings and specifications. This phase would also include interrelationship with other Plans and Designs, such as Regional Tourism and Economic Development Plans.

Phase 6. – Implementation of Conservation/Stabilization Measures.

Phase 7. – Continuing Conservation or Historic Preservation Maintenance.

This process plan would include details of all professionals, specialists and others involved in each phase and throughout the process. Also included would be reporting and reviewing processes and stages; and details of directors and phase managers, including their appropriate fields of expertise or professions. A stabilization-process management matrix should be prepared which would include the following elements and interrelationships:



Draft matrix.

When the matrix has been developed, appropriate decisions can then be made on staffing, financing, and location of the associated infrastructure.

As has been noted, there is currently no system of conservation dossiers in existence for the cultural and natural properties under consideration, apart from the excellent records of the mural paintings' conservation teams on the Tokalı Church, for example. These full conservation dossiers are crucial to the conservation and basic management of all cultural and natural properties. The maintenance and careful storage of such records are today fundamental aspects of the conservation profession's philosophy, practice and professional ethics.

The establishment and maintenance of an archive of such dossiers is both timely and critical! Without the dossiers there is no way of maintaining an up-to-date record and understanding of the states of the unique cultural properties, including their structural conditions which may constitute a major threat to their immediate and continuing conservation.

Permanent Scientific and Technical Conservation Centre

It is recommended that a permanent Scientific and Technical Conservation Centre should be established in the middle of the region as soon as possible.

This Centre could include limited technical facilities to assist in field investigation and analytical studies; equipment and instrument storage; and the maintenance and repair of scientific equipment.

One complete set of the Conservation Dossiers for every single cultural and natural property within the designated archaeological and natural zone would be deposited at the Centre. The dossiers would be maintained and updated with every inspection and intervention on each cultural or natural property. The dossier system should be augmented by a supporting photographic and documentary archive.

It is recommended that an existing building or group of facilities should be used for the proposed Centre rather than construct a new facility at this stage.

At least two facilities have been identified which are sufficiently large and conveniently located for such a Centre. It might be appropriate that at least part of the facility be rock-hewn.

The proposed Centre could also act as a focal point for all or part of the processes of publication and distribution of reports and data originating from the various conservation and stabilization projects, and for other activities of an educational or scientific nature.

It is not necessary for the first facilities to be permanent. They could be replaced by more suitable facilities at a later date. It is, however, essential that they are located in the middle of the region, in close proximity to the cultural and natural resources, but not so close as to cause any aesthetic, visual or physical damage to the resources. It is also essential that the work of stabilization moves forward immediately without further delays, and the use of existing premises are essential to this end.

Proposal from Working Group Nº 4

MURAL PAINTING CONSERVATION

Statement of the Present Situation

Two successful treatments of conservation/restoration have been achieved on Tokalı church (1973-80) and Karanlık church (1980-90). In the same period, emergency treatments have been applied at the Elmalı - Barbara complex, El Nazar, Saklı and Kı lı çlar churches.

Given the similarity of the conditions and of the nature of mural paintings in the Cappadocia area, the conservation techniques developed during these treatments can be proposed in other cases, even though they must necessarily be adapted to the specific case.

However, it is suggested to experiment with new and possibly useful conservation materials and application techniques that have received approval elsewhere. The most complicated and time-consuming operation is "cleaning." Due to the generally high sensibility of the paint layer, irreversible damage can be induced if under-qualified technicians carry out the operation.

Until now, conservation and restoration treatments have been applied in the five major churches, but from now onwards an inventory of the other churches is needed for the establishment of priorities based on the state of conservation, historical importance and tourist appeal of the various monuments.

Mural paintings are part of the whole complex. They are directly related to the rock structure and to the degradation process of that rock. Deterioration mechanisms of mural paintings and rock support cannot be considered separately. The rock structures of many churches are unstable and erosion processes are of a dynamic type.

Promising results have been obtained from experiments that have been carried out to try and solve structural problems, and the consolidation and protection techniques developed (plaster capping, grouting of joints and cracks, deviation of water, etc.) should be now applied on a larger scale.

Continuous monitoring of cracks is still lacking, even in churches which are in extremely unstable condition.

Tourism is concentrated too much in the Open Air Museum and its vicinities. Anthropogenic damage has increased in several dimensions all over the Cappadocia region.

Numerous churches are little known or in very remote locations. Mural paintings in these churches are subject to theft and vandalism as site protection is completely absent.

The training of mural painting conservator-restorers promoted by ICCROM in the past years has increased the number of competent Turkish technicians. Unfortunately, most of them live far away from the site and cannot dedicate much time to the Göreme project due to their involvement in their regular work.

Proposal for further actions

An interdisciplinary site committee of national and international experts must be formed and should meet on a regular basis. Conservator-restorers of mural paintings should have the same status as the other members.

Moreover, it is recommended that a local team of conservators and engineers be formed, which should be permanently (or at least during the dry season) based on the site.

This team should include local people as far as is possible. For this purpose, special training of local technicians should be undertaken under the direction of competent conservators who have many years of experience with the problems on the site. Competent conservator-restorers should also be in charge of the work supervision.

To allow the effective realization of such activities, it is recommended that special effort be made to overcome current bureaucratic and management difficulties as soon as possible. We hope that the new law will go a long way towards solving the problem.

A full survey of the whole territory is needed to establish priorities and to identify longer-term management needs, regular daily needs, and more urgent and dramatic cases, requiring special and urgent attention. To this end, it is suggested the inventory file developed by the Istituto Centrale per il Restauro (ICR), Rome, for the realities of rock-hewn churches in southern Italy, be used as the basis – after reshaping and re-assessing requirements – for a similar inventory file for the monuments in the Cappadocia region.

The survey file should be modified so as to include anthropogenic damage, problems of ownership, accessibility, and land use, all of which are relevant issues for the preservation in the local situation.

This survey is also urgently needed in order to establish priorities regarding emergency treatments, preventive maintenance and long-term conservation and restoration policy.

If the present funding situation does not improve, it is suggested that structural and surface emergency treatments and preventive maintenance interventions be implemented rather than complete conservation and restoration treatments.

Emergency stabilization must be carried out jointly by a team of structural technicians and mural painting conservator-restorers.

As an immediate priority, it is suggested that a programme be established to carry out the following actions simultaneously over the whole territory:

- Survey.
- Emergency treatments.
- Preventive maintenance.
- Evaluation of former treatments.

It is also suggested that a site workshop be established, with the basic equipment for the needs of the site.

To maintain the improved conditions obtained in the churches of Tokalı and Karanlık, suitable regulations and systems must be implemented (before the re-opening of Karanlık church) to avoid anthropogenic damage. Mural painting conservators must be involved in the study and planning phases.

These churches must be included in a continuous maintenance process consisting of microclimatic monitoring, regular inspections and small-scale treatments where needed.

Suitable lighting systems and the microclimatic impact of visitors must be studied, especially in small and poorly ventilated churches.

For the visitor access problem, we recommend that, in particular cases, alternatives be found to physical visits inside the churches. These could include simulations, copies, or didactic museum displays.

If immediate control is not possible, it is recommended that the monument be closed temporarily.

ADDITIONAL REFERENCES

This section contains the list of publications circulated to all participants prior to the seminar. The references identified appear here substantially as they issued from the computer. The material was sought in the Conservation Information Network [CIN] database, which combines the library listings of ICCROM, Rome; Conservation Analytical Laboratory [CAL], Washington, DC; the Canadian Conservation Institute [CCI], Ottawa; the Getty Conservation Institute [GCI], Marina del Rey, CA; The International Council of Museums [ICOM], Paris; and the International Council on Monuments and Sites [ICOMOS], Paris.
The abstracts accompanying some of the references are those available in the database. Many of them were prepared by ICCROM; others were done by volunteers for the Art and Archaeology Technical Abstracts system [AATA].

Abbreviations used:

ABS	=	Abstract
AUT	=	Author
DTP	=	Date of Publication
SHLF	=	Shelf number (ICCROM)
TISRC	=	Titlesource
TIT	=	Title

A – Text references available at ICCROM

TISRC=Turquie - developpement touristique et mise en valeur des sites et monuments historiques (Cappadoce, Pamphylie, region d'Izmir).
AUT=Sanpaolesi, P.; P. Roselli; R. Nencioli; A. de Lorenzi.
DTP=1966
ABS=Report prepared by UNESCO for the government of the Republic of Turkey. Presents findings and recommendations regarding touristic development.
SHLF=Mission Turquie 1966

AUT=Weaver, Martin E.
DTP=1969
TISRC=Preliminary research into the performance of pencapsula and polyvinyl acetate coatings as field conservation media for building materials: a re-examination of the Göreme problem.

SHLF=Miss. turquie 1969/1

TISRC=Master plan for protection and use: Göreme Historical National Park.
DTP=1971
ABS=Revised master plan for the park management. Analysis of resources: significance, history, archaeology, cultural resource, natural history. Background information: setting, access and circulation, climate, land use, population, visitors. Development and management: objectives, protection and preservation, buildings and towns, visitor facilities, organization. Appendixes with exhibits, publications, guidebooks, research needs, recommended conservation. With bibliography and illustrations.
SHLF=VIII turquie 4a

TISRC=Dossier concerning a project of restoration of the mural paintings of Göreme (ICCROM).
DTP=1971
ABS= Historical importance; conservation problems; project and programme for mural painting restoration.
SHLF=Miss. turquie 1971/2

TISRC=Programme for the conservation of the rock churches in the Göreme area (ICCROM).
DTP=1972
ABS= Revised version of the 1971 dossier; covers all aspects of conservation.
SHLF=Miss. turquie 1972/1

TISRC=Eglise de Tokalı . Göreme. Mission septembre - octobre 1973.
DTP=1973
SHLF=Miss. turquie 1973/1

AUT=Burckhardt, Jacqueline.
DTP=1974
TISRC=Rapport de la deuxième mission à Göreme en Turquie (13 septembre - 28 octobre 1974).
SHLF=Miss. turquie 1974

AUT=Granier, Jean.
TISRC=Etude de la conservation structurale du site de Göreme.
DTP=1974
SHLF=Miss. turquie 1974/2

AUT=Dangas, Isabelle.
TISRC=Rapport de la troisieme mission a Göreme en turquie. 7 septembre - 26 octobre 1975. (complement aux rapports de J. Burckhardt et R. Bouquin). Eglise de Tokalı .
DTP=1975
SHLF=Miss. turquie 1975/1

AUT=Bouquin, Robert; Dangas, Isabelle; Robouch, Tatiana; Schwartzbaum, Paul.

DTP=1976
TISRC=Interim project report: the conservation of rock churches in the Göreme area, Turkey.
SHLF=Miss. turquie 1976/1

AUT=Schwartzbaum, Paul; Silver, Constance
DTP=1978
TISRC=1977 and 1978 mission report: Conservation of the churches in the Göreme valley, Turkey.
ABS=Report on the campaign for Tokalı Kilise: the mural paintings were completed and emergency structural interventions were implemented. Emergency conservation treatments were undertaken in two other churches in the Göreme valley: Kılıçlar Kilise and Karanlık Kilise.
SHLF=Miss. turquie 1978/2

TISRC=Conservation des peintures de l'eglise de Göreme. Mission, ICCROM, 3 septembre - 3 octobre 1980.
DTP=1980
ABS=Short report on the works carried out by the Turkish ICCROM team on the mural paintings of the churches of Tokalı, Karanlık, Kılıçlar and Elmalı.
SHLF=Miss. turquie 1980/1

TISRC=Göreme, Karanlık Kilise. Mission report, September 1981.
DTP=1981
ABS=Report on the state of conservation of an excavated crypt of volcanic tuff with byzantine mural paintings. The intervention of restoration is described: consolidation and reattachment of the intonaco and painting surface, cleaning.
SHLF=Mission turquie 1981/2

TISRC=Göreme - Turchia. Chiesa di Karanlık, chiesa di El Nazar. Indagini sui materiali costitutivi.
DTP=1982
ABS=Report on the analyses of pigments (red and yellow ochre) plasterwork and volcanic tuff. X-ray diffraction, chemical, qualitative, stratigraphy. Vegetable fibre (Graminaceae). The binder is not calcium carbonate but rather a vegetable gum.
SHLF=Mission turquie 1982/1

TIT=Special International Campaigns.
TISRC=World Cultural Heritage Bulletin
DTP=1982
ABS=Special issue on UNESCO International Campaigns. Financial aspects. News from five campaigns: San Francisco de Lima (Peru); la Plaza Vieja, Havana (Cuba); Wadi Hadramaout and Shibam (Yemen); Göreme and Istanbul (Turkey); and Sana'a (Yemen). Special reports on Moenjodaro, Venice, Göreme and Montenegro.
SHLF=Per. UNESCO 9

TIT=International campaign for the Safeguarding of Istanbul and Göreme.
TISRC=World Cultural Heritage Bulletin
DTP=1984
SHLF=Per. UNESCO 9

AUT=Dangas, Isabelle.
TISRC=Göreme. Rapport des missions 1981, 1982, 1983, + traitements de conservation et restauration.
DTP=1985
ABS=Mission report on conservation carried out on various rock churches of the site of Göreme in Turkey. The treatments are listed and graphic documentation included.
SHLF=Miss. turquie 1985/1

AUT=Dangas, Isabelle.
TISRC=Göreme. Rapport des missions 1984 et 1985, + traitements de conservation et restauration. Tomes i-ii-iii.
DTP=1985
ABS=Mission report on conservation carried out on various rock churches of the site of Göreme in Turkey. The treatments are listed and graphic documentation included.
SHLF=Miss. turquie 1985/2

TISRC=Göreme, structural consolidation, ICCROM mission, 8-14 September 1985.
DTP=1985
ABS=Report of an ICCROM mission to Göreme (Cappadocia, Turkey) to carry out some practical experiments within the framework of the project for the consolidation of the rock churches. Contents: field experiments for the protection of rock domes undergoing rapid erosion, and the grouting of rock structures. Study of the pilot projects of Elmalı, El Nazar, and Meryemana churches. Information on laboratory support by Middle East Technical University and on future development of the project.
SHLF=Mission turquie 1985/3

AUT=Errahmani, Abdelkader Brahim.
TISRC=International campaign to safeguard the historic quarters and monuments of Istanbul and the site of Göreme.
DTP=1985
SHLF=Mission turquie 1985/1
ABS=An outline of a national plan for promotion and financing, prepared as a result of a mission to the national authorities on the international campaign for safeguarding the historic quarters and the monuments of Istanbul and the site of Göreme. Background on the international campaign and its main principles, promotional activities undertaken by UNESCO, basic approach of the proposed plan, objectives of the campaign and its strategy.

AUT=Bowen, Robert.
TISRC=The structural conservation of Göreme, Turkey. Rain gauge installation.
DTP=1985

ABS=Report of the mission, guided by Dr. Robert Bowen, hydrogeologist and ICCROM consultant, organized at the request of the Turkish authorities to the site of Göreme from 18 March to 2 April 1985 for the installation of four Munro sestrel automatic gauges in relation to the structural conservation project. With complete technical data on installed equipment. Bibliography.
SHLF=A 30 10

TIT=Structural conservation of Göreme.
TISRC=Tripartite Review Meeting (27 November 1986)
DTP=1986
ABS=Proceedings of a meeting organized by the Turkish Ministry of Culture and Tourism and the General Directorate of Antiquities and Museums with contributions by O. Kabar (Project Coordinator), E. Caner (Chemist, Middle East Tech. University), B. Canic (Ankara University), I. Yılmazer (Hydrogeologist, Hacettepe University), R. Ozil (Archaeologist-restorer, Centr. Cons. Lab. Istanbul), N. Muftuoglu (Art Historian, member of the conserv. team) on a wide range of conservation problems.

AUT=Lizzi, F.
TIT=Static reinforcement of the rock-hewn churches in the Göreme valley.
DTP=1986

AUT=Malliet, J.; Rossi, P.P.
TISRC=Göreme, structural consolidation, ICCROM mission, 28 July-02 August 1986.
DTP=1985
ABS=Report of the 2nd ICCROM mission to Göreme (Cappadocia, Turkey), to carry out some practical experiments within the framework of the project for the consolidation of the rock churches.
SHLF=Mission turquie 1985/3

AUT=Schwartzbaum, Paul M.
TIT=The conservation of the mural paintings in the rock-cut churches of Göreme.
TISRC=Tokalı Kilise: tenth-century metropolitan art in Byzantine Cappadocia.
DTP=1986
ABS=A description of the ICCROM-sponsored conservation (1973-1980) of the rock churches of Göreme, Turkey. The programme emphasized structural stabilization of the rock masses and conservation of the mural paintings. Tokalı Kilise was selected as the pilot monument for painting conservation because of its deteriorated condition: detachment of the plaster, friability and scaling of the pigment-bearing layer, and damage caused by vandalism. The fresco technique is described. The plaster was re-attached by injecting a mixture of calcium caseinate, lime and casein, with an admixture of polyvinyl acetate emulsion; smaller areas were injected with polyvinyl acetate emulsion or *Primal AC33* diluted in water. The delicate surfaces were cleaned mechanically and with a variety of chemical agents. Lacunae were filled with watercolour washes, and a final protective fixation of *Paraloid B72* in lacquer thinner was applied. Two emergency structural interventions were implemented to prevent water infiltration, but much more maintenance is required. References.
SHLF=XI B turquie 4

AUT=De Witte, Eddy.
TISRC=Investigation on the conservation of the Göreme rock.
DTP=1987
ABS=A series of tests were applied to the rock of Göreme; they included petrographic examination, porosity, saturation coefficient, pulse velocity and water absorption. Effects of impregnation with consolidants based on silica esters and water repellents were monitored under artificial ageing. The best results against the mechanical action of rain droplets were obtained by the consolidants, while the water repellents were found to have limited protective effects.
SHLF=A 88 587

AUT=De Witte, E.; Terfve, A.; Koestler, R.J.; Charola, A.E.
TIT=Conservation of the Göreme rock: preliminary investigations.
TISRC=VIth International Congress on Deterioration and Conservation of Stone. Torun, Poland, 12-14 September 1988. Proceedings.
DTP=1988
ABS=The underground rock churches in the valley of Göreme, Turkey, are deteriorating. This is caused, in major part, by the action of rainwater on the volcanic tuff. Laboratory studies were carried out on freshly quarried tuff from the site to evaluate possible protective treatments. The results from artificial aging of treated and untreated samples were examined by changes in physical parameters and scanning electron (SEM) microscopy. — [AATA]
SHLF=no data CAL
SHLF=XIX D 207/1 (ICCROM)

TIT=Investigation of the mechanisms of stone deterioration for the purpose of conservation of Göreme tuff- Progress report by the Middle East Technical University, Ankara.
DTP=1987

TISRC=Structural conservation of Göreme. Project findings and recommendations.
DTP=1988
ABS=Report prepared by UNESCO for the Government of the Republic of Turkey, presenting findings and recommendations regarding the project for the structural conservation of the rock structures in the valley of Göreme, Cappadocia. A summary of the activities carried out includes photogrammetrical survey, rock sample analysis, meteorological, topographical and hydrogeological surveys, expert missions, study tours and fellowship programmes. List of documentary output is provided, including ICCROM reports.
SHLF=Mission Turquie 1988

AUT=Bowen, Robert.
TIT=The future of the past at Göreme in Turkey.
TISRC=The Engineering Geology of Ancient Works, Monuments and Historical Sites: Preservation and Protection. Proceedings of an International Symposium, organized by the Greek National Group of IAEG, Athens, 19-23 September 1988 = La geologie de l'ingenieur appliquée aux travaux anciens, monuments et sites historiques: preservation et protection. Comptes-rendus d'un symposium international organisé par le Groupe National Grec de l'Aigi, Athens, 19-23 Septembre 1988.
DTP=1988

ABS=The structural conservation project at the Göreme site, with its rock-hewn churches, is a program for safeguarding this area in Cappadocia. This paper is an inquiry into the causes of deterioration and aims to define a general plan of intervention. The first problem noted is erosion. To natural erosion must be added the effects of localized erosion resulting from increasing tourism at the site. The second difficulty is to be seen in fissuring and fracturing in the soft rock, a volcanic tuff. Treatment of fissures in domes involves complete covering of the rock. Low-pressure injection grouting with a product suitable for the fissures would assure water tightness of the monument and restore to the rock mass its monolithic stability. — [AATA]

AUT=Malliet, Jef.
TIT=Building stones: aspects of conservation.
TISRC=The Engineering Geology of Ancient Works, Monuments and Historical Sites: Preservation and Protection. Proceedings of an International Symposium, organized by the Greek National Group of IAEG, Athens, 19-23 September 1988 = La geologie de l'ingenieur appliquée aux travaux anciens, monuments et sites historiques: preservation et protection. Comptes-rendus d'un symposium international organisé par le Groupe National Grec de l'Aigi, Athens, 19-23 Septembre 1988.
DTP=1988
ABS=Some conservation concepts related to building stones are illustrated by three recent ICCROM research projects: a study of the structural conservation of the rock-hewn churches in Göreme, Turkey; the consolidation by micro-injection of the cornerstones of a tower of the Palazzo del Senatore in Rome; and the preliminary documentation by computer of the conditions of a part of the Servian Walls in Rome. — [AATA]
SHLF=no data CAL; VIII d 667/2 (ICCROM)

AUT=Caner, E.N.; Türkmenoglu, A.G.; Göktürk, H.; Demirci, S.; Böke, H.
TIT=Examination of surface deterioration of Göreme tuffs for the purpose of conservation.
TISRC=Vith International Congress on Deterioration and Conservation of Stone. Supplement. = Vie Congrès International sur l'alteration et la conservation de la pierre. Torun, Poland, 12-14 September 1988.
DTP=1989
ABS=Extensive surface alterations of rock-cut churches, such as colour change, exfoliation, and granular disintegration, have been examined, starting with the surface down to about 10 cm depth. Mineralogical and petrographic examination have been done by X-ray powder diffraction analysis, optical microscopy, and scanning electron microscopy coupled with EDAX. Soluble salt content has been determined by using spectrophotometric methods as well as Ph and conductivity measurements. Restricted microclimatic investigations have been performed by taking temperature and humidity measurements of the surfaces and the atmosphere in winter and early summer. The results have been interpreted in terms of the types of alteration, the depth of alteration, and possible methods of conservation. — [AATA]
SHLF=XIX D 207/2 (ICCROM);no data CAL

AUT=Yorulmaz, M.; Cili, F.; Ahunbay, Z.
TIT=Structural consolidation of El Nazar church, Cappadocia, Turkey.
TISRC=Structural Repair and Maintenance of Historical Buildings. Edited by C.A. Brebbia
DTP=1989

ABS=El Nazar is a mediaeval rock-hewn church situated in the Göreme valley of Cappadocia in Central Anatolia (Turkey). Deeply concerned with the continuing deterioration of the monument due to climatic and hydrogeological factors, the Turkish Ministry of Culture and Tourism asked the Technical University of Istanbul to determine the measures necessary for the preservation and consolidation of the structure. The results of the investigation and the proposed interventions are presented in this paper.
SHLF=04116234

AUT=Grissom, C.A.
TIT=The deterioration and treatment of volcanic stone: a review of the literature.
TISRC=*Lavas and Volcanic Tuffs:* Proceedings of the International Meeting. Easter island, Chile, 25-31 October 1990. Charola, A.E., Koestler, R.J., & Lombardi, G, eds.
DTP=1994
ABS=A literature review reveals that conservation studies of volcanic stonework have focused on tuffs, which exhibit serious deterioration. Other volcanic rocks used for monuments or sculpture are basalt, scoria, andesite, dacite, rhyolite and trachyte. Important examples include the statues at Easter Island, the Buddhist shrine of Borobodur in Java, the churches at Göreme in Turkey and Lalibela in Ethiopia, the rock-cut Buddhas of Japan, and the caves of the Deccan plateau in India. The application of consolidants has been the treatment most frequently tested, but little is known about long-term efficacy. Monuments carved *in situ* present particularly intractable problems.
A list of products used in their conservation is provided.
SHLF=XIX D 223 ICCROM

B: Other text references

AUT=Daifuku, Hiroshi.
TISRC=Report on the international campaign to safeguard historic monuments and sites in Istanbul and Göreme (Cappadocia), Turkey.
DTP=1983
SHLF=V.H. 813

AUT=Anon.
TIT=Les couleurs secretes d'un paysage lunaire: les eglises troglodytes de la Cappadoce.
TISRC=Informations UNESCO
DTP=1983
ABS=The rock-hewn churches in the Zelve and Göreme valleys were dug out of volcanic rock and are conical in shape; they served first as places of meditation before being used as impregnable places of refuge during the successive invasions. All the various Byzantine styles are to be found in their architecture and wall paintings. The area has suffered very badly from the effect of rain and landslides, and emergency measures are to be taken to arrest the deterioration, particularly in the case of the churches of El Nasar, Elmalı and Karanlık. — [AATA]
SHLF=K-109;no data CAL

TIT=Pour la sauvegarde d'Istambul et de Göreme: un appel du Directeur General.
TISRC=Les Nouvelles de l'UNESCO = UNESCO News
DTP=1983
SHLF=no data ICOMOS

TIT=Istanbul et Göreme: deux faces du visage historique et culturel de la Turquie.
TISRC=Patrimoine Culturel de l'Humanite
DTP=1983
SHLF=V.H. 625

AUT=Errahmani, Abdelkader Brahim.
TISRC=Campagne internationale pour la sauvegarde des quartiers historiques d'Istanbul et du site de Göreme; Esquisse d'un plan national de promotion et de financement dans le cadre de la campagne internationale.
DTP=1984
SHLF=no data ICOMOS

AUT=Ozil, Revza.
TIT=Göreme 1981 Yili Çalishmaları.
TISRC=IV. Kazi Sonuçlari Toplantısı: Ankara, 8-12 Subat 1982
DTP=1983
ABS=Natural erosion has continued for centuries in Cappadocia in the Göreme Valley, chosen as the primary region for structural conservation and rescue of the wall paintings. Today the site shows deterioration in several dimensions. The conservation and restoration of the wall paintings of Göreme rock-hewn churches was started in 1973 with the cooperation of Turkish Ministry of Culture and Tourism, Middle East Technical University (METU), and ICCROM, and a team of ICCROM and Turkish specialists continuing the rescue activities each year. In 1981, conservation studies continued in Dark Church and Monastery of Nuns. Some consolidation of the supports and cleaning procedures are reported.

AUT=Ozil, Revza.
TIT=Göreme, Karanlık Kilise Duvar Resimlerinde 1983 Yili Koruma ve Onarim Çalıshmaları.
TISRC=II. Arashtırma Sonuçlari Toplantısı: Izmir, 16-20 Nisan, 1984.
DTP=1985
ABS=The restoration and conservation studies of Göreme rock churches continued on the frescoes of the Dark Church in 1983 with the support of ICCROM and the Turkish Ministry of Culture and Tourism. Before this project, whole painting surfaces were under observation and 3% *Paraloid B-72* solution was applied to some. Mechanical and chemical methods were used in the cleaning procedure. Lastly, the protective materials were applied to the surfaces. Related studies will be continued over the coming years.

AUT=Ozil, Revza.
TIT=Göreme, Karanlık Kilise Duvar Resimlerinde 1984 Yili Koruma ve Onarim Çalıshmaları.
TISRC=III. Arashtırma Sonuçlari Toplantısı: Ankara, 20-24 Mayis 1985.
DTP=1986

ABS=The project, which is supported by ICCROM and the Turkish Ministry of Culture and Tourism, includes different stages of conservation and restoration studies in Göreme. After the extent of deterioration of the surfaces was determined, mechanical and chemical methods were applied. In 1984, conservation and restoration studies were completed at the central dome and some other surfaces in the Dark Church in Göreme.

AUT=Ozil, Revza.
TIT=Göreme, Karanlık Kilise Duvar Resimlerinde 1985 Yili Koruma ve Onarim Çalishmaları
TISRC=IV. Arashtirma Sonuçlari Toplantısı: Ankara, 26-30 Mayis 1986.
DTP=1986
ABS=Restoration and conservation studies were conducted on the frescoes in the Dark Church in Göreme in 1985. First, the paint layer was consolidated carefully. The surfaces were cleaned and the cracks and lacunae were filled with suitable mortar. Some surfaces were re-integrated and all were covered by protectants. In addition to these studies, similar conservation studies were conducted at the Saint Barbara Church and Elmalı Church in Göreme.

AUT=Epstein, Ann Wharton.
TISRC=Tokalı Kilise: tenth-century metropolitan art in Byzantine Cappadocia
DTP=1986
ABS=Tokalı Kilise (Buckle church), located in Göreme valley, Cappadocia, Turkey, was the main church of the Monastery of the Archangels. Its 10th-century frescoes are a provincial manifestation of the "Macedonian renaissance" and shed light on the territorial and societal limitations of a revival style. The author discusses the chronology of the church's construction and decoration, the iconography of the fresco cycle, and its historical significance. Appendixes on the conservation of the murals (by Paul M. Schwartzbaum), on colour analysis, on scenes and inscriptions in the old and new churches, and bibliographical notes. Extensively illustrated.
SHLF=XI B turquie 4 (ICCROM)

TISRC=Göreme kaya kiliseleri bir fotogrametrik belgeleme. The rock-cut churches of Göreme. A photogrammetrical survey
DTP=1986
SHLF=VIII B turquie 28
ABS=The international campaign launched by UNESCO for the preservation of the rock churches of Cappadocia (Turkey) includes a structural conservation project with a preliminary photogrammetric survey of the structures. The various drawings collected for the churches of El Nazar, Elmalı, St Barbara, Meryemana, Kılıçlar, are reproduced. In small spaces, hand measurements were used.

AUT=Ozil, Revza.
TIT=Göreme, Karanlık Kilise Duvar Resimlerinde 1986-1987 Yılları Koruma ve Onarim Çalıshmaları.
TISRC=VI. Arashtirma Sonuçları Toplantısı.
DTP=1988
ABS=In the Dark Church, Göreme, several methods were employed for conservation and restoration. The support, plaster layers, and paint layers were consolidated. The pigmented layers were also treated and re-integrated with *acqua sporca*. The deep cracks

and lacunae in the support and plaster layers were filled with the suitable mortar. Some external conservation studies were conducted as well on other churches and their entrances.

AUT=Ozil, Revza.
TIT=Göreme, Karanlık Kilise Duvar Resimlerinde 1988 Yili Koruma ve Onarım Çalıshmaları.
TISRC=VII. Arashtırma Sonuçları Toplantısı.
DTP=1989
ABS=A report on the conservation and restoration studies continued in Göreme Dark Church in 1988 which were concentrated on the right and left sides of the lower part of the church stage. Survey research and conservation studies were also done in El Nazar Church this year. The foundation of the church has been supported by two walls.

AUT=Thierry, N.
TIT=Destruction of the sites and mural paintings of Cappadocia: natural, and human causes.
TISRC=Science, Technology and European Cultural Heritage: Proceedings of the European Symposium. Bologna, Italy, 13-16 June 1989. Edited by N.S. Baer, C. Sabbioni, and A.I. Sors.
DTP=1991
ABS=The destruction observed in Cappadocia has natural and human causes. The natural cause is erosion by wind, water and frost. The cliffs fall, together with the churches located inside them (e.g., today in the Ihlara valley, formerly in Çavushin). The human causes are numerous. The destruction of the sites, landscapes and villages is due to mass tourism. There is progressive destruction of the sites of Ürgüp, Ortahisar, Göreme-Avcılar-Çavushin (Historical Center), Avanos, etc., as a consequence of the anarchical multiplication of gigantic hotels, of restaurants, camping and shopping centres, of the opening of new roads and large parking lots, of the destruction of the ancient centres and construction of new ones in conflict with the environment. The agricultural setting is destroyed; peasants and tourism workers have opposing interests. In the case of the churches, in the most often visited churches (chiefly in Göreme), the paintings are attacked by the moisture and carbon dioxide emitted by the visitors jammed inside (up to 5 000 a day); direct abrasive rubbing away is also obvious. In isolated or unguarded churches, the damage has numerous causes: graffiti of the tourists and destruction by the Muslim villagers. The very ancient paintings of the basilica of Çavushin, VIIth century, were destroyed in 1983-1984, and those of St George of Zindanönü, VIIth c., in 1987-1988; as well as others in Göreme itself: faces and inscriptions in Kılıclar Kilise, Xth c. and in Saklı Kilise, XIth c. This kind of damage is currently increasing.
SHLF=XXI 277 (ICCROM)

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