

UNITED NATIONS EDUCATIONAL,  
SCIENTIFIC AND CULTURAL ORGANIZATION

CONVENTION CONCERNING THE PROTECTION OF  
THE WORLD CULTURAL AND NATURAL HERITAGE

World Heritage Committee  
Fifteenth Ordinary Session

Carthage, Tunisia, 9-13 December 1991

Item 6 of the Provisional Agenda:

**MONITORING OF THE STATE OF CONSERVATION OF  
CULTURAL WORLD HERITAGE PROPERTIES AND  
RELATED TECHNICAL PROBLEMS**

1. During its fourteenth session, the Committee, at the suggestion of the Secretariat, expressed the wish that replies to the questionnaires received on the state of preservation of sites be analysed and submitted to the Bureau and that data-records by countries and sites be established. During its fifteenth session, the Bureau, upon information provided, decided to suggest to the Committee to suspend the mailing of questionnaires. It furthermore considered that a diagnosis site by site such as mentioned at the fourteenth session of the Committee and of which a sample was submitted to the Bureau was a major element of the monitoring system.

Within the framework of this systematic examination, 19 sites located around the Mediterranean Basin have been visited. This exercise enabled the collection of an important amount of information which the Secretariat holds at the disposal of the Committee members. Many problems could be identified when reading the above information. Before drawing conclusions which might seem evident, the Secretariat considered it should get in touch with the national authorities to obtain further information which it was not possible to gather before the present session and, where necessary, propose possible means of correction measures. During its next session, the Secretariat will report to the Committee on the result of the steps taken by then. On the basis of the complete information at its disposal, the Secretariat is however in a position to submit a summary of the state of conservation of sites mentioned below. Furthermore, certain Latin-American sites are covered in a separate document prepared by the Co-ordinator of the UNDP/UNESCO Regional Project on Cultural Heritage and Development of Latin America and the Caribbean.

2. Xanthos-Letoon (Turkey)

Xanthos, which consists of an archaeological area covering approximately the ancient city and the archaeological site of Letoon, forms a whole which was inscribed on the World Heritage List in 1988 under criteria (ii) and (iii). At the time, ICOMOS had underlined in its comments the need for a management plan including, in particular, the control of the environment in Letoon and had noted that a road crossed the site of Xanthos, and that it would be desirable to divert it.

The mission sent on site in the course of 1991 to assess protection and management problems noted that as to Xanthos the road had been asphalted in 1989. This road not only bears an increasingly heavy tourist traffic, but also runs through several large villages in the valley of Xanthe and this entails a very dense traffic flow of tractors, lorries, and minibuses. It successively runs along the monumental gate of the ancient city, the theatre (cf. below) and a large tomb, which are under constant threat. It would therefore be advisable to divert it in order to keep clear of the ancient site. There presently exists an earthen track which skirts around the acropolis of Xanthos and rejoins the asphalt road. Its conversion would keep access to the mountain villages while protecting the site. Necessary expropriations would be insignificant. It would be very desirable that this solution be examined and carried out.

The rubble of the theatre, situated at the north of the acropolis, encroaches on the above-mentioned road. The laying out of this surrounding area is indispensable for both practical and aesthetic reasons. It would result in improving the appearance of the theatre and its approaches much visited by tourists and in allowing a better understanding of the different phases and characteristics of its construction.

Thanks to bilateral assistance, the Department of Monuments and Museums of the Ministry of Culture considers undertaking the strengthening of the early Christian mosaics of the Agora Church, proceeding with the reinforcement of the mosaics of the Great early Christian Cathedral, as well as covering the nave, and putting back into place the sarcophagus tank known as "The Dancers" which was damaged by acts of vandalism .

During its fifteenth session, the Bureau was informed that the cement public conveniences would be maintained on the site of Xanthos. This matter is the subject of a correspondence between the Secretariat and the Turkish authorities.

As regards Letoon, two preservation measures should be suggested to the authorities. In the first place, it is urgent to stop alluvial deposits from collapsing along the present access road to the sanctuary by building a low retaining wall. In the second place, it is equally indispensable to dig on the strip of land running along the road a new irrigation canal which would divert water from the archaeological site which it constantly threatens.

Moreover, tractors, trailers, lorries and cars are presently allowed at the southern border of the site, beside the early Christian church and the Roman

nymphaeum. However outside the excavation period, vehicles cross the sanctuary by way of the temple terrace. Noxious to the appearance (dust) and to the preservation of the monuments, this access should be prohibited in future.

At a more specific level, the reinforcement of the mosaic of the Apollo temple should be completed and the mosaic put back in place ultimately.

Finally, since the theatre is used every year by the Kumlu Ova community for the celebration of the *Tomato Festival*, there is a risk of some loose architectural blocks of collapsing. Strengthening works should be undertaken at the north-east gate.

It is interesting to note that the Turkish authorities have defined "special environmental protection areas" in which all development projects liable to modify the environment and the ecosystem are submitted to the control of a special council which is competent namely in all actions taking place within the context of international conventions. The area of the Xanthe delta and mouth has thus been declared a "special environment protection area" by decree No. 90/77 of 18.01.1990 published in the Turkish official bulletin on laws of 02.03.1990.

### 3. The City of Valletta (Malta)

The City of Valletta was inscribed on the World Heritage List in 1980 under criteria (i) and (vi). Its monuments are protected on the national level by an Antiquities (Protection) Act of 1925. An ideal fortified town, founded in the XVIth century by the Order of Saint John of Jerusalem, Valletta has undergone very little alteration in its urban fabric and its architecture. A great number of important monuments were preserved, among which the famous Auberges of each language: 320 historical monuments within 55 hectares.

The major conservation problem of Valletta is the same for almost all the island: the nature of the globigerina limestone which constitutes the highly crumbly basic building material used. However, maritime humidity and pollution seriously damage the façades and the decoration of the monuments and buildings.

Most of the monuments showed deterioration and alteration problems of the stone (the globigerina has an alveolate structure). Many of these monuments damaged during the Second World War have not had basic repair and are still undergoing makeshift and 'temporary' repairs: the Auberges of Italy, Bavaria, Provence, the Hospital of the Order, and the Grand Masters' Palace. The Department of Museums and the Ministry of Civil Engineering are responsible for maintenance and restoration works. The Church authorities are in charge of the restoration of churches and other religious properties. There is for the time being no safeguarding plan for Valletta (a project is under way). There exists, however, a committee for the restoration of Valletta which acts as technical adviser in cases of modification of the façades, etc.

A request for technical assistance was granted in 1981 for the establishment of a research section in the laboratory of the University of Malta and

for equipment for the Hal Saflieni Hypogeum, in order to study stone conservation problems through different testing methods: silicification, impregnation, replacement of blocks, etc. The Committee also has under consideration a request for assistance concerning air conditioning in the hypogeum.

An International Campaign for the Safeguarding of Malta was launched in 1981. The action plan comprised conservation works, in particular, for the Hal Saflieni Hypogeum, the megalithic temples, and the Fort Saint Elmo in Valletta, but only the hypogeum was subject to a thorough monitoring. The Forts Saint Elmo and Saint Angelo belong to the Army and are not being restored, although they need several restorations. However the bastions at the entrance gates are being maintained, restored, and refitted. These forts are a part of the government's restoration plans which provide for tourist use of these places. This should be watched carefully to prevent possible deterioration due to a high flow of visitors. Emergency plans should presently consist in putting in place legal and control instruments (setting up and adopting a safeguarding plan) and enabling a better knowledge of the technical means allowing to slow down the deterioration of the stone.

4. As a result of activities financed by extrabudgetary sources, such as UNDP or funds collected under international safeguarding campaigns, the Secretariat has obtained information on the work carried out or projects pending in some of the sites inscribed on the World Heritage List. Thus, for the Old City of Sana'a (Yemen) on which a report has been submitted to the Committee at its previous session, twenty-four restoration projects have been developed within the framework of the international safeguarding campaign. Details are given in a brochure published by UNDP and UNESCO and put at the disposal of Committee members.

5. Old walled City of Shibam (Yemen)

Three restoration projects have been developed within the context of the international campaign for its safeguarding. Inscribed on the World Heritage List under criteria (iii), (iv) and (v), Shibam, former capital of Wadi Hadramaut, is called the "Manhattan of the desert" because of its tall houses reaching up to seven or eight stories and entirely built of clay. Founded in the 4th century A.D., and situated at the meeting point of the wadis, it was an important halt on the spice and incense routes. It has been partly destroyed by devastating floods and rebuilt on its old foundations several times in the past.

A considerable amount of work has already been completed in Shibam by the Campaign Office, principally: the restoration of two sultans' palaces, the repair of almost the entire city wall, and the installation of a waste water drainage system.

The Muza dam was burst by floodwaters and has been rebuilt several times in the past, most recently in the disastrous floods of 1983 and 1989. Considerable damage was also done to the earthen retaining banks of the main

channel and the diversion canals. The main causes were the silting-up of the area behind the dam wall and the diversion channels, and obstruction of the flow of water from the main road bridge to the east of Shibam. A new drainage system has been completed by the Campaign Office, serving the whole of the old city. New domestic water supply pipes have been laid throughout the city, above street level in order to control leaks. All the streets and open spaces of the old city should be paved in order to protect the foundations of the buildings from infiltrating water and salts from animal waste. It is suggested that all future restoration projects should include in their budget provision for the paving of the surrounding area.

Three projects have been developed by an UNESCO consultant and will be proposed as extrabudgetary funding.

- (1) Project No. 1 - Beit Jarhum House Museum. Located to the north-west of Shibam, **Beit Jarhum** is reputed to be the oldest house in the old city, its age being variously estimated at between 400 and 500 years. It shows a combination of the typical causes of decay to be observed in the old city. Some years ago, a burst water main caused the north-west corner to settle and severe cracking to appear. Poor maintenance of the protective lime plaster of the upper stories has led to leaks through cracks, the collapse of parts of the roof, and damage to the floors below resulting from rainwater penetration. Conservation of doors and windows will consist of cleaning, repairing broken parts, tightening joints and replacing missing parts with matching wood. The setting of the future museum is almost equally as important as the building itself. In order to protect the foundations, it is proposed that the paving of the surrounding area be included in the project. The whole of the work should amount to 270,000 dollars of the United States of America.
- (2) Project No. 2 - Masjid Haroun al Rashid (Grand Mosque). One of the earliest buildings in Shibam, it is typical in its layout of the oldest mosques in Wadi Hadramaut. The presence of red baked bricks in the plinth at the north-west corner is the only known example in Shibam. The minaret was rebuilt c. 1970 A.D. in the baroque style. An unfortunate concrete block structure was in the course of construction in front of the mosque to house the drinking water cooler. The mosque is, in general, structurally stable, with no sign of recent settlement. The major area needing urgent attention is the roof, which is leaking in several places, and the walls suffering from moisture infiltration. Conservation work would be restricted largely to maintenance, with the exception of the minbar, which needs specialist attention. Termite-infected wooden members which have lost their mechanical strength should be consolidated with epoxy or polyester resins. The work has been estimated at 250,000 dollars of the United States of America.
- (3) Project No. 3 - Madrassa al Fatah wa Amdad. This fine mosque-madrassa fell into disuse when the modern school was built in the opposite corner of the city. Two stories high, with a fine minaret and domed entrance, it fell into ruin. The roof and large parts of the floor have collapsed, and the action of rain has weakened the mud suspended floor and basement walls of the mosque. In order to ensure the permanence of any future restoration works, the root causes of

decay should first be remedied. The paving of the surrounding streets should be included in the project, in order to protect the foundations. The project is estimated at US\$180,000.

**6. National History Park - Citadel, Sans Souci, Ramiers (Haiti)**

Inscribed in 1982 on the World Heritage List under criteria (iv) and (vi), the site was subject to a restoration and improvement programme from 1979 to 1990 under UNESCO's and UNDP's technical and financial assistance.

A. The **National History Park** very diversified combines imposing monuments, Citadel, Sans Souci, Ramiers, in a rural mountain environment. The National History Park was created to preserve this natural background from King Christopher's achievements. The intricacy of the problems, the concern about being in a position to conduct an efficient action and to prevent dispersion led to limiting the area to 25 sq. m. In 1978, at the request of the Haitian government, preparatory missions sent by UNESCO elaborated with the national authorities the restoration and implementation programme for these monuments and their environment. The *Institut de Sauvegarde du Patrimoine national (ISPAN)*, established in 1979, was responsible for the protection policy of the national heritage and the study and execution of safeguarding projects, and the implementation of specific representative elements of the heritage. In 1979, ISPAN presented the ISPAN/UNDP/UNESCO project which comprises the conservation plan of the Citadel, of the site of Sans Souci, and of the fortified site of the Ramiers, and the development of monuments and sites for cultural purposes. The setting up of workshops for which a training programme was proposed fitted in with this project. Begun in 1979 the joint work ISPAN/UNDP/UNESCO officially ended on 21 July 1990. When the project started, archives and documents were almost non-existent so that it was necessary to conduct a careful interpretation of the buildings and pinpoint them in detail. Investigations enabled the delimiting of the different stages of construction, as well as of the techniques utilized. One of the objectives of any development programme or of any international campaign for the safeguarding of monuments and sites being the reinforcement of the national capacity to ensure the preservation and the improvement of its heritage, an intensive training programme was set up. Between 1980 and 1987, the most active period of restoration work, twenty-two technicians received a theoretical and practical training: architects, engineers, draughtsmen and heads of building sites.

In order to enlarge possibilities for technical assistance thanks to the project, an international campaign for the safeguarding of the Citadel, Sans Souci and les Ramiers was launched in 1980. An American committee, the United States Committee for Restoration of the Citadel (USCRC), responsible for the organization of the American campaign and the promotion of the project in the United States was created in December 1987. The purpose of this non-profit-making committee was to make known the project of preservation of the monuments and to collect the necessary funds to pursue the restoration work. The World Monuments Fund also supported actively the project by identifying new financing sources within private American foundations. Finally, as from 1981,

other financial contributions were granted for selective operations under bilateral assistance, following the steps undertaken in Haiti with diplomatic representatives of Member States. Over the years, the project developed rapidly in a way that could not be predicted at its conception, partly due to the socioeconomic development of the area because of the creation of employment and the ever increasing interest of the national and international community for the project. Despite budgetary restrictions and changes which have taken place in the country since 1986 and which delayed the works, the project's objectives were achieved. The Haitian government contributed 2,373,273 dollars for the restoration of this complex, UNDP and UNESCO, 2,688,863 dollars.

B. Analysis of the state of the **Citadel** quickly indicated the need to stop rainwater infiltration which threatened the structures, some of which were already seriously damaged by the 1842 earthquake. If the work carried out twice, in 1930/1933 and 1950/1955, saved the **Citadel** from ruin, twenty years later it was no less urgent to reconsider saving it from flooding. This has been the main objective of the project implemented after two years study. The work allowed the detection of the different phases as well as the building techniques used. Among the many solutions considered to save the **Coidavid Battery** from flooding, there was chosen the laying of a covering made of very long aluminium trays onto the framework reconstructing the original floor by using one joist out of two. The traces of the original state of the **Royal Battery** were sufficiently large to enable a historically exact reconstruction. This restoration work allows the protection of some 1,200 sq. m of buildings from flooding. As for the terraces, research was directed towards waterproofing. The techniques selected are based essentially on the imposition of a waterproof layer in the form of a concrete slope, covered with waterproof bituminous mortar; a thick paving ensures finish and protection.

C. As is the case for the **Citadel**, all the buildings of **Sans Souci** are in rubble work. The **Palace** roof is covered with slates. This group of monuments was serviced by an outstanding hydraulic system; in 1979, reservoirs and piping were still buried underground. Torrential rain beating down on the unprotected masonry increased fissures and contributed to the collapse of walls and the detaching of the remaining plaster. The major objective was to clean up the site. Above all it was necessary to carry out soundings and excavations in order, on the one hand, to bring to light the original piping, and to better understand the constructions, on the other hand. The preservation method selected turned on strengthening and improving the remaining elements, every restoration, even partial, being excluded where original documents were lacking.

D. In 1972 the fortified site of **Ramiers** was cleared of the luxuriant vegetation that covered it. The same materials as those of the other monuments are used. The redoubts are in a better state of conservation than the residential complex, but are not easily accessible since the drawbridges which gave access to it have disappeared. The preservation method selected was the strengthening of existing elements and the enhancement of the architectural monuments as a group.

7. **Kathmandu Valley (Nepal)**

The Kathmandu Valley has already been mentioned during the Committee's last session. Since then, the Secretariat has obtained new information during the meeting of the working group responsible for the monitoring of the International Campaign for the Safeguarding of the Valley of Kathmandu which took place early in October 1991. Since the launching of the campaign in 1979 notable progress has been made, on the basis of the 1981 master plan, in the conservation work at some of the seven areas protected under the World Heritage Convention. The major work includes: (1) the restoration of Kathmandu Durbar Square, especially at Hanumandhoka Palace, Lohan Chowk which is intended to house a museum (Mahendra Memorial Museum and the Prithivi Gallery), Nasal Chowk, Lalitpur Tower and Bilas Mandir; (2) Swayambhunath Hill stabilization and conservation work; (3) Patan Durbar Square, restoration of Keshav Narayan Chowk; (4) Bhaktapur, restoration of the palace and historical houses; Changu Narayan Temple, initial conservation work; Pashupatinath, preparation of a preliminary conservation plan. The report prepared by the working group can be consulted by Committee members at the present session. Furthermore, three extrabudgetary projects were developed in 1990/91 to support the national authorities:

(1) The UNESCO/UNDP Project NEP/89/060 "Preservation of the cultural heritage of the Kathmandu Valley and development of cultural tourism" intends to increase the capacity of the Government to preserve and present the cultural heritage of the Kathmandu Valley as a whole, and to develop a more integrated approach by improving the linkages between the preservation of cultural heritage and overall physical planning, tourism and education. The total budget is estimated at US\$435,000 for three years. It is expected that the agreement on the financing of the project will be concluded in the spring of 1992.

(2) The Nepal/UNESCO/Japan Trust Fund 536/NEP/71 "Preservation of the selected monuments in the Kathmandu Valley" foresees restoration works on several monuments and the development of Patan Durbar Square. The carrying out of this project the cost of which is estimated at US\$376,300 begun in October 1991.

(3) The Nippon Institute of Technology is presently undertaking the restoration of a Buddhist monument in Patan thanks to funding by the Japanese government (US\$300,000).

For the meeting of the working group, Professor Eduard Sekler, an international expert who has been technical adviser to the Nepalese Government and the Director-General on the implementation of the Campaign for over ten years, undertook monitoring investigations with the authorities in charge of the seven areas concerned. Detailed reports on these missions will be sent to the Secretariat which will submit them to the Committee at its next session.



8. **Archaeological Ruins at Moenjodaro (Pakistan)**

Inscribed in 1980 on the World Heritage List under criteria (ii) and (iii), the site is the subject of an international safeguarding campaign. It was described as "one of the greatest metropolises of the most ancient East". To date, approximately 800,000 sq. m have been exposed, estimated to be about 10% of the total site. At the time of excavation, the standing brick walls were found to be relatively well-preserved. Soon afterwards, however, development of white salt efflorescence was observed on the walls. The brick has been rapidly deteriorating because of salt crystallization and hydration, which has resulted in exfoliation and disintegration of the brick. Most of this salt damage has been attributed to the destructive effects of sodium sulphates. A serious threat to Moenjodaro was posed by the river Indus. The bed of the river has shifted considerably over the years and has clearly flooded Moenjodaro in the past. Of late it has shown a tendency to move westward towards the remains. A master plan, developed with the assistance of UNESCO, provided for the following work: (1) the lowering of the ground water level; (2) the armouring of the existing bunds facing the river so as to pin down the extreme limit of the current at an optimum safe distance from the existing right bank of the river; (3) a number of steps to be taken for the preservation of archaeological remains; (4) landscaping of the site and planting of salt resistant trees and grass to reduce the drifting of salt and its carriage by wind. Since it was apparent that the cost of the work could not be borne by Pakistan alone, an international campaign was launched by UNESCO in 1979 to mobilize international support. To date 7 million dollars have been collected thanks to governmental and private donations. In addition to this, the government estimates that it has spent 9.5 million dollars and that an additional amount of approximately 7 million (based on 1988 costs) will be required to complete the campaign.

Since the launching of the campaign, a significant part of the major infrastructural elements foreseen by the master plan has been accomplished, particularly with regard to the protection of the site from flooding and the lowering of the ground water level. Over the next years, it will be necessary to complete further work required with regard to these two aspects, so that further effort can be concentrated on the preservation of archaeological remains. Presentation of the archaeological remains to visitors must be a prominent theme in the plans for the site, including steps to be taken to prevent damage to the site by the visitors. An overall plan for the site must therefore be developed having particular regard for the relationship between the preservation and exploitation of Moenjodaro as an archaeological site and its development as a cultural tourism facility.

Within the framework of the UNDP Five-year Plan (1988/93) for Pakistan, priority is given to the safeguarding of archaeological sites, including Moenjodaro. A project has been approved in 1991 to this effect for an amount of US\$595,000.

9. When examining item 11 of the agenda concerning international assistance, the Committee will have to consider a request by Bulgarian authorities in relation to the Madara Rider. This monument, inscribed on the World Heritage List in 1979 under criteria (i) and (iii), is at present in great danger according to the expert report annexed to the present document. Reading the report reveals profound differences in opinion as to the methods to be applied for the conservation of the Madara Rider. It seems that the hypothesis of displacing the sculpture is considered. This does not however meet the agreement of UNESCO's expert. In any case and even before the necessary studies have been completed which should determine the modes of conservation agreed upon, the Committee might wish to question the situation of a property whose conservation can only be ensured by displacing it from its original context. The question indeed is to know whether a property or a site inscribed on the World Heritage List, of which one of the elements has been taken away, can be maintained on the List, in particular when the displaced element has been a determining factor in the inscription.



## REPORT ON THE MISSION TO THE MADARA HORSEMAN

Bulgaria, 9-23 September 1991

by Dario Camuffo on behalf of UNESCO

### 1. Problems and research needs

After having inspected *in situ* the Madara Horseman, and discussed with all the local experts present during the mission, and examined the existing documentation (written only in Cyrillic, and verbally translated by courtesy of Dr. Valentin Todorov, Chief of the Research and Technological Laboratory, National Institute for Cultural Monuments, Sofia), several problems of different nature arose. The main ones are:

- (i) lack of convergence of opinions
- (ii) static stability of the rock
- (iii) biological weathering
- (iv) atmospheric weathering
- (v) mineralogical deterioration.

The above problems will be commented on the following. Some notes on the studies planned by the National Institute for Cultural Monuments, Sofia, will be added, together with other research needs that were seen.

### 2. Lack of convergence of opinions

The first difficulty is the lack of convergence of local opinions on the real extent of the problem, the possible solutions and priorities regarding the studies that should be carried out. Opinions range from removing the Horseman and preserving it in the museum, to leaving it *in situ*. But in the latter case suggestions also range from: leaving everything untouched; to anchoring the rock slabs and consolidating the bas-relief; to heating and drying the Horseman by drilling the rock, inserting heating tubes and forcing ventilation behind it; to building a glass enclosure

the bas-relief. These two cracks, combined with other minor fractures, form two big triangular prisms, inclined toward the slope. The main points are:

(i) The static problem is of fundamental importance in the conservation of the Horseman: in the case of the rock being irremediably destined to fall, its removal is necessary; in the case that the rock may be safely anchored, the Horseman may be preserved *in situ*, once all the other existing problems have been solved.

The existing engineering and geological conditions should be carefully determined; the stability and the risk of the monument of falling down should be evaluated, especially during earthquakes. The course of major fractures and minor cracks inside the rock is still largely unknown and requires further investigation, some of which are underway. The ultimate aim is to anchor all the existing slabs and wedges to give a certain static stability.

In addition to the studies already planned, an ultrasonic mapping of the secondary crack system would be useful in order to improve our knowledge of the fractures behind the Horseman, the penetration and retention of rainwater in the near surface layer. Mr. Marc Mamillan, President of the Stone Committee of ICOMOS (CEBTP, Paris), may be usefully requested to give some scientific and technical support in this field, for both the Madara Horseman and St. Stefan, Nessebar.

(ii) Other difficulties may possibly arise, owing to the horizontal layer of clay below the sandstone rock massif, as it may increase its thickness when it is soaked, changing the force distribution inside the rock and along the fissures. Studies are underway.

(iii) The situation is further complicated by boulders falling from the top of the massif just over the bas-relief. All the free boulders should be removed or clamped. Also, some major slabs of rock may fall elsewhere into the Madara valley, coming from the front of the massif. However, these events are independent and occur separately during earthquakes.

(iv) Once stability is guaranteed, all the fissures that allow rivulets of rainwater to penetrate into the rock should be carefully sealed at the top of the massif. In fact, two other negative effects may be caused by the infiltration of rainwater and should be investigated. The first is the hydrostatic pressure of water penetrating into the fissures and that may push out wedges of rock behind the Horseman. The hydrostatic pressure is probably largely reduced thanks to the absorption of water into the pores of the rock; however, the pores could also be filled with mud

this reason it seems to be advisable to stop the biological deterioration as soon as possible and substitute this weak biological binding with a new, chemically induced, mineralogical binding.

As the rock is porous and with several cracks, it is not easy to distinguish between endo- and epilithic organisms. The first 2 cm layer is densely filled with biological species, but several hyphae can also be found at a depth of 50 cm and these decrease the strength of the bindings between the sandstone granules. The biological agents penetrate the micro and macro cavities of the sandstone and the organic matter content is very high: 1 to 2% of C is organic. Many organic acids are released by all these agents. They penetrate to a depth of 50 cm and at a depth of 30 cm they reduce their concentration to 50%.

Dr. Petko Petkov (Poushkarov Institute of Soil Science, Sofia) and Dr. Rossitsa Neshkova (Institute for Monuments of Art, Sofia) have identified 30 species of lichens: 3 species of *verruca* *cariaceae*, 2 *dermatocarpaceae*, 1 *dipoloschistaceae*, 3 *collemaceae*, 1 *pennariaceae*, 4 *lecideaceae*, 6 *lecanoraceae*, 8 *candelariaceae*, 2 *physciaceae*.

There are also various kinds of algae. A list made by Prof. Stephan Jordan Draganov (Faculty of Biology, Sofia University, now retired) includes the following. *Chyanophytae*: class *chyano* *phyceae*, *chroococcales*: *chroococcaceae* (9 species); *nostocales*: *scytonemantaceae* (2 sp.); *nostocaceae* (2 sp.); *oscillatoriaceae* (4 sp.); *chlorophytae*: *chlorococcophyceae* *chlorococcales* (several species); *hydrodictyaceae* (1 sp.); class *ulotrichophyceae* *chastophorales* *trentepohlia* *ceae* (1 sp). Algae are always present, but in spring they are more evident.

Fungi are always present also and penetrate very deeply into the rock, for several tens of cm, probably reaching a depth of 1 m.

There are many types of bacteria: nitrifying ones, heterotrops and phototrops. Heterotrophic bacteria may live eating organic matter of dead microorganisms.

The study planned by Dr. Petkov and Dr. Neshkova is aimed at:

- (i) investigating with laboratory models the biological activity and trophical connections of epilithic and endolithic associations (phototrops, chemotrops, metylotrops and heterotrops) in the sandstone;
- (ii) controlling and adapting non destructive tests for both qualitative and quantitative studies of biological deterioration;

the technical point of view, and needs to be absolutely reliable. Its reliability cannot be guaranteed in the case of interruptions to the power supply: it must be noted that, last year, the power supply in that region was alternatively 3 hours on and 1 off.

For the same reason the hypothesis of drilling the rock behind the Horseman to install a heating and ventilating system should also be discarded. In addition, this hypothesis works against the rock stability.

It is also useful to mitigate the winter cooling of the rock. This aim may be reached in two ways: (i) the cheapest way is to protect, in the cold season (winter and beginning of spring) the bas-relief with a mobile insulating cover. It is not a very restrictive factor that the monument is covered during this limited period: in fact, in wintertime tourism is very scarce, or absent. (ii) From the aesthetic point of view, the best, but much more expensive method, is to supply some radiant heat by means of infrared sources at a relatively low temperature.

A very useful intervention is to protect the bas-relief against rainwater, with the help of a shield; an additional protection is making it waterproof.

## 6. Mineralogical deterioration

The mechanical resistance of the rock was diminished due to partial de-cohesion of bindings between the granules as a consequence of biological weathering, chemical dissolution of acid rain, break off due to freeze-thaw cycles and other phenomena, as has been previously discussed.

After cleaning, the sandstone should be consolidated with inorganic substances that are natural constituents of the rock (not resins), capable of penetrating deeply (say 1 m), and allowing unhindered transpiration through the pores. Tests should be made *in situ*, on the rock near the Horseman, and the effect of the treatments should be controlled for several years.

After, the stone should be made water repellent using similar field tests.

Problems, methods and materials have been extensively discussed with Dr. Valentin Todorov and Mr. Peter Popov (Chief Restorer, National Institute for Cultural Monuments, Sofia) who seem capable of these experimental tests and draw the due conclusions without major problems.

avoiding any disagreeable aesthetical effect

## **8. Summary of the suggested actions**

In conclusion, the following actions are suggested:

- (1) Studying the stability of the rock. In the event that the geological results were absolutely negative, the Horseman should be removed and preserved in a museum. In the much more probable case in which the rock can be consolidated, all the necessary interventions should be made, and the Horseman could thus remain safely in its natural, historic setting. Some environmental measurements and ultrasonic tests should also be made.
- (2) Removing or anchoring all the unstable boulders and sealing all the fissures responsible for infiltration of rainwater from the top.
- (3) Carrying out tests *in situ* (but not on the monument itself) with biocides and cleaning methods to remove the organic substances. Observing the reliability of the results for several years.
- (4) Carrying out tests *in situ* (but not on the monument itself) to consolidate the sandstone and to make it hydrophobic without reducing its transpiration. Observing the reliability of the results for several years.
- (5) Inserting over the bas-relief an upper shield to act as an umbrella against raindrops, biological nutrients and acids, spores and other substances falling from the upper zone.
- (6) Attenuating the winter cooling by means of a temporary insulating shield or with some infrared radiation.
- (7) The findings obtained from the tests made on the rock for cleaning and consolidating it, and verified over the long run, should be applied to the Horseman.

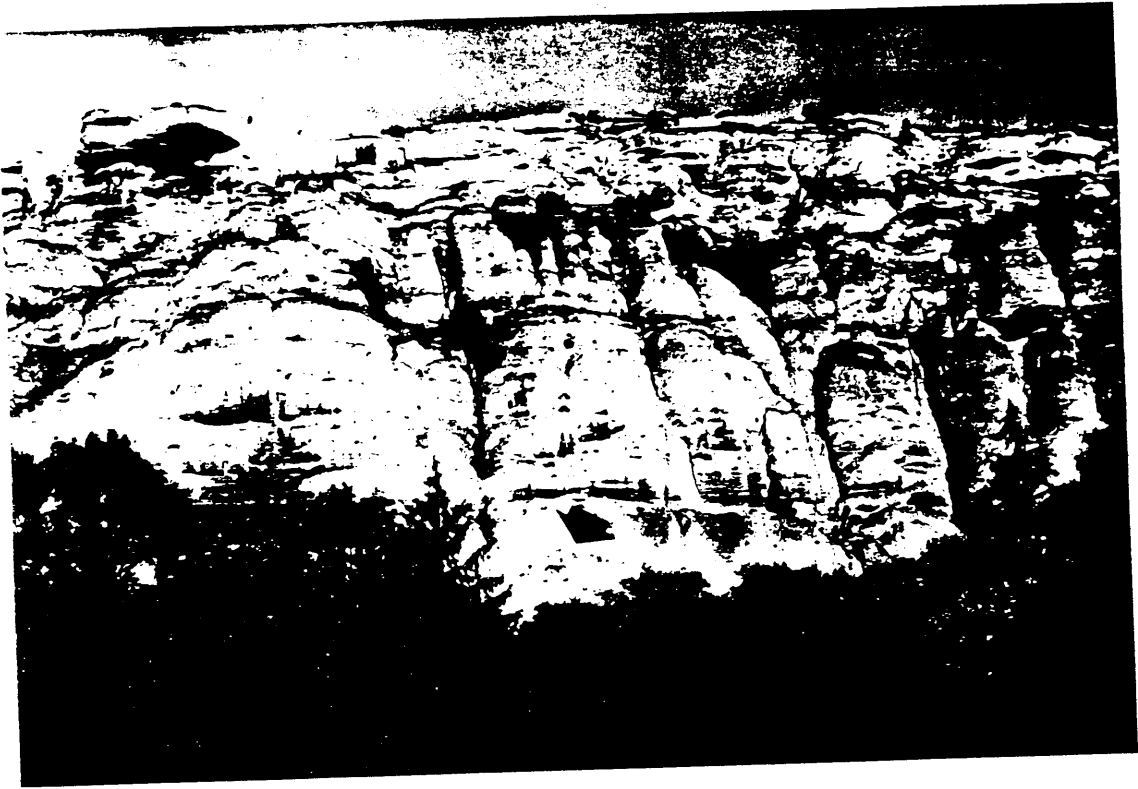


Fig. 1 - The Madara rock massif with the Horseman (indicated with an arrow)



Fig. 2 - The Horseman