

*New technologies and materials for the conservation and management of historic cities, sites and complexes*

Introducing lecture to the 4<sup>th</sup> International Symposium on the Conservation of Monuments in the Mediterranean Basin

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The 4<sup>th</sup> International Symposium on the Conservation of Monuments in the Mediterranean Basin opens today in Rhodes with the theme “new technologies and materials for the conservation and management of historic cities, sites and complexes”. Each of the previous editions of the Symposium had a specific theme. The first Symposium in Bari in 1989 dealt with the problem of the marine aerosol and considered its effects on limestones and marbles, in particular of the Mediterranean coastal areas where the corrosiveness of the environment is enhanced by salts of marine origin. The second Symposium, in Geneva, focused on analytical techniques and interventions on marbles, especially antique marbles; while the following Symposium in Venice considered methodologies for the analyses of decay and the conservation of stone.

The theme of the 4th Symposium concerns historic cities and complexes, which represent a large part of the unique historic-architectonic heritage of the Mediterranean. The historic cities and archaeological remains allow experts in the

sector to evaluate both the evolution of decay on the stone with the effects of pollution which followed the industrial revolution and of which the monuments are the primary indicators, and also to evaluate the natural hazards to which the monuments have been and are exposed: earthquakes, landslides, floods, subsidence, volcanoes, great fires and various types of disaster. We therefore believe that the interpretation of the environmental effects and the importance of the evaluation of those risks represent today a natural and irreplaceable potential that the scientific community is able to offer in to an up date way for the development of methods of treatment, conservation and restoration of cultural properties on one hand, and on the other for the territorial planning and protection of the archaeological areas and of the monumental zones.

In the previous editions of the Symposium many contributions made to the understanding of the phenomenologies effecting the decay of monuments came from research programmes promoted by the European Community. The first programme, Framework (1986-90), had defined the consequences of atmospheric pollution through the examination of important monumental buildings as well as through the monitoring and control of air quality. The second programme, Step (1989-92) for science and technology for environmental protection, above all examined the impact of particles deposited on the monuments and archaeological sites, while the third programme, Framework (1993-95), promoted more detailed research regarding the marine aerosol, non-destructive techniques and new methods of evaluation of

cultural properties. Many other important contributions came from programmes conducted by research groups that work in Institutes and Laboratories, Universities, Museums and private organizations.

The Symposium on the Monuments of the Mediterranean is undoubtedly characterized by the interdisciplinary character of the scientific contributions, which are presented within the following topics: a) stone materials employed; b) physical, chemical and biological weathering processes; c) forms and mechanisms of decay, d) laboratory methods and techniques; e) the evaluation of decay with non-destructive techniques; f) environmental parameters; g) historical, technological and structural features of monuments, h) treatments: materials and methods; i) case studies of monuments.

At the start of our meetings there was a clearly evident recognition of a lack of systematic surveys on these topics and, also, of the gap between some countries of the Basin and those which are more industrialized and for which economic resources provide the necessary space for scientific research. Despite the recognition of this initial situation, it seems important to stress that the active participation of colleagues, who in the course of these years have presented the results of important researches, the exchanges of information and the new procedures of analysis and intervention that emerge from time to time, have all begun to fill in effectively the most evident gaps, through the system of information

which is represented by the Proceedings of the different editions of this Symposium.

We know very well how difficult it is to extrapolate the results of this type of research, in that the various weathering forms of the monuments are indicators of interconnected combinations of variables (materials, atmosphere, environment, ground and natural and anthropic hazards) which condition the difficult and complex interpretation of the different parameters on which the state of decay of each monument depends. Therefore, in this context it is necessary to indicate clearly the limits of the generalization of the phenomenologies observed and described, while the utility of the progressive contribution of knowledge is certain, it originates in the informative data and stimulates further research.

The initiative undertaken by the IGCM (International Group for the Conservation of Monuments in the Mediterranean) presently aims to assess a number of micro-territorial situations without these being representative samples of a reality as complex as that of the Mediterranean Basin or even only interpretative of the specific phenomena which occur in the different countries of which many of these are the expression. Besides, the qualitative and quantitative aspects of the weathering phenomenon are linked to considerable ranges of indicators and parameters due to the significant distance between each country, so that, with regard to situation, the archipelagological character of the Basin seems evident at first sight.

However, is the picture of local situations which is progressively reconstructed perhaps lacking in content? In fact, from the results so far obtained thanks to the thematic character of the various editions of the Symposium, there already seem to be clear returns both from the approach attempted with the now distant Bari Symposium and from the character of the contents offered by the research methodologies and intervention techniques proposed.

On the occasion of that Symposium I said that to be occupied with the monuments of the Mediterranean and discuss common experiences of the conservation of that heritage “acquires a particular ethical and cultural significance since the attention of the scientific world is concentrated on a basin which holds the biggest and most important historic, artistic and archaeological heritage of the world; a basin which witnessed the birth and growth of the great civilizations of the past; a basin which, though it is very large and varied in character, is, in any case, a single entity from the historic, artistic, archaeological and environmental points of view”. It was from that Symposium that the invitation was made to the scientific community for periodic meetings with the objective of the conservation of the monuments of the great civilizations of the past. I recalled, in fact, that only in very recent times: “facing notable impoverishment and environmental decay, our countries chose to change their attitude, drawing on a trend which saw in the systematic remodelling of huge areas the re-establishing of a more balanced relationship between the natural environment and the constructed environment. The

prevention of further damage and the attainment in a short time of a general enrichment of the potential available to man has always been the aim of that trend and of the resulting environmental policy, which has come to involve also the historic and artistic heritage. Therefore, in the context of that policy, which revolved at first around the concept of defence for its own sake, there has been a gradual passage to one of care, maintenance and management. Parallel with environmental policies there has also been the development of the interesting innovation in the organization processes for interventions on the historic and artistic heritage. The fact that specific technical and scientific knowledge is required for various aspects of conservation has led to the passing over of the pure historic-artistic aspect of the problem leaving more space for the competence necessary to plan the various types of intervention. The technical-scientific element has benefited from this broadening. It has been able to assure appropriate solutions made possible by recent technological developments and it has helped the establishment of a multi-disciplinary science which has formed gradually from traditional professionalism with the aim of supplying an inheritance of deep knowledge, sophisticated techniques and advanced methodologies”.

The IGCMM Group believed in this new proposal and, in putting it into practice, it has made possible the scientific involvement in the context of the community which today deals with the specific problems of study and intervention.

Organized research programmes have been created such as that on the effects of the marine aerosol which aggravates the conditions of exposure of the monuments. After the first studies, directed to clarifying the complex dynamics of a phenomenon which favours and intensifies the deterioration of stone exposed on the coasts, the tendency is now to determine the real conditions of risk. In fact, although the studies so far carried out on the chemical-physical processes of weathering have allowed important findings to be made on the consequences of these processes, it remains to completely clarify the mechanisms that allow salts of marine origin to accelerate the natural processes of weathering of stone for the singular nature of the problem which requires a specific approach and a selection of analytical techniques necessary for the investigation of what is a very particular subject. There is a particularly urgent need for deeper research in this direction when it is considered that conservative interventions on monuments exposed in marine environment have very often been largely ineffective in view of the appearance of forms of decay linked to the effects of salts which have remained trapped in the pores and microcracks. Once established, therefore, that in the stone materials with systems of porosity and/or microcracks, the deposition of salts on and below the exposed surfaces depends on degree of solution and the evaporation level, it becomes essential to develop forecast models of susceptibility to the action of salts for stone materials of different compositions and structures which are exposed in different environmental conditions.

The analyses of the weathering of stones employed in the Mediterranean Basin has also contributed to the development of non-destructive techniques, among which those carried out by means of ultrasonic pulses have demonstrated the role of exposure time and of pollutants of natural and anthropic origin as factors determining the acceleration in the development of the forms of weathering and the thickness of the decay levels. The environmental conditions necessarily have a fundamental role where the conditions of exposure to the pollutants are very severe. The influence of time is also seen in the thicknesses of the decay layers and the depth reached by neo-formation salts which are found to be comparable in many cases, independently of the specific forms of surface decay which characterize them. It is known, in fact, that the development of these forms may depend on the particular petrographic character of the stone, its structural and textural characteristics and the cutting and positioning of the stone in the context of the monumental buildings.

The researches on the environmental parameters of the Mediterranean have also shown, on the basis of correlations of data regarding environmental monitoring on pilot monuments, that there is a clear relationship between the chemical composition of the wet and dry depositions and weathering forms. In the context of the reactions which occur on the surrounding rock-environment binomial, both the natural and anthropic pollutants determine an aggressive system in which the effects accumulate due to the circulation regime of the air, typical of the sea-breeze, and



are repeatedly dispersed and returned by circulation cells. Dust, smoke and mists are the products of pollution which interact with the stone of the monuments. Through environmental monitoring it is already possible to observe different acidity levels in the depositions, which are found to be especially high in correspondence with large urban centres where polluting anthropic activity is concentrated. The compositions of the aerosols generally include elements such as sulphur, chlorine, potassium and calcium enriched by metallic elements such as iron, copper and zinc or vanadium and manganese, specific to particular microenvironmental situations and with considerable variations from area to area.

With regard to chemical weathering processes, research in the Mediterranean has also indicated cementitious crusts, which were discussed at the Venice Symposium. These crusts are completely different from the widely known black crusts, being amorphous formations rich in silicon, aluminium and calcium and containing particles rich in iron the origin of which is to be traced to the emissions of the cement industry.

The contributions offered to this specific field of scientific research are of undoubted interest because this data forms a promising basis for the creation of a forecast model of susceptibility of stone to weathering in the Mediterranean environment. A deeper understanding of the problem will also come from the contributions of research programmes which aim both to clarify and understand

more deeply the role of salt crystallization and to propose expert chemical models which can establish the degree of risk.

Also in the biological processes of weathering in the Mediterranean Basin, and above all in correspondence with local situations effected by especially high levels of atmospheric pollution, the *surface environment* favours the growth of microorganisms which are resistant to solar radiation and to sudden changes of humidity, such as demaziacious funghi, cyanobacteria which contain pigments (melanins and carotenoids) capable of protecting them from harmful effects. Given the unfavourable conditions of this environment, which are to be considered as *extreme* for most of the year, the polimicrobial colonization does not take place in a homogeneous form, but in the form of metabolically active niches which act on the surfaces of the rock solubilizing the calcium carbonate and leading to a characteristic pitting.

On the techniques and laboratory methods and on the evaluation of the weathering of stone material employed in the Basin, the specialized literature published in the Symposium Proceedings has already offered many valuable contributions of undoubted interest for the widening of the possibilities of application and for the extension of controls.

I also recall that from the controls of the effectiveness of conservative treatments further non-destructive techniques have been developed on the stone materials employed in the Basin. These have made it possible to overcome the limits

presented by traditional methodologies and to circumvent the comparison of treated and untreated laboratory samples when the operation of sampling cannot be carried out on the sculptured and architectonic surfaces. This is without doubt an innovative approach in scientific research, employed on site to verify the depth of penetration in microcracks and pores of consolidants that ensure the cohesion of the weathered parts and their adhesion with the more integral parts below.

With regard to the historic, technological and structural aspects of the monuments of the Mediterranean, though there are specific congresses at which specialists in the sector meet, this Symposium retains exclusively the treatment of those aspects which are dealt with on a multidisciplinary level for the formulation of general proposals concerning care, maintenance and management. It is on these aspects of conservation that it will be necessary to continue to do much work in the future, since the Mediterranean presents a vast context with large numbers of archaeological sites and with natural hazards which in many places threaten our great heritage. At the Venice Symposium I recalled that: "The diagnosis of the decay of monuments also involves the assessment of their conditions of structural damage. At the basis of that assessment there is, however, the determination of the causes which undermine the safety of a structure to the point where it becomes a ruin. The techniques and methods for diagnosis and for suggesting adequate remedies are of very recent application in the field of the conservation of monuments and their range is not well understood by all, otherwise more space

would have been given to the existing potentialities and research could have provided many more results in this specific sector.

This concerns, in particular, a series of investigation methodologies which are linked to geological and hydrogeological elements of the whole Mediterranean area, and that are employed in order to evaluate the conditions of natural risk. Active tectonics and seismicity, subsidence and landslides, volcanic eruptions and floods, are all phenomena which respond to the geology and meteorological conditions of the Mediterranean region.

A synthetic balance has not yet been attempted of these phenomena, nor have the methods of approach been identified to the systematic studies which must necessarily be carried out in the sector of cultural properties”.

This is, therefore, a brief summary of the problems around which the members of the IGCM Group periodically return with the commitment to reserve for the Symposium specific and original scientific communications. There is also a common interest to feel involved in arguments that broaden the fields of knowledge, open out horizons and stimulate research which contributes to the protection of the world’s greatest archaeological and historic-architectonic heritage.

The opening of the work of the Symposium is the occasion to welcome all the participants to Rhodes and to express to all contributors appreciation for the scientific contributions offered.

Sincere thanks are also due to the Prefect of the Dodecanese and the Authorities of the City of Rhodes, Ministries, Universities, Institutions and public and private organizations which have supported the initiative, and to all those who have actively collaborated from the scientific and organizational point of view to the successful outcome of the 4th Symposium.