EUREKA PROJECT E!496 - EUROCARE EUROMARBLE

1. General description

Project	E! 496 - EUROCARE EUROMARBLE **Status**		Finished - 01-AUG-2000
Title	**Mode And Extent Of Physical, Chemical And Biological Deterioration Processes On European Marbles**		
Class	Sub-Umbrella	**Technological area**	Environment
Start date	01-JAN-1990	**End date**	01-JAN-1999
Duration	108 months	**Total cost**	1.48 Meuro
Partner sought	No		
Summary	Study Of The Phenomenon Of The Radical Structural Breakdown Of Marble Grain Structures. This Kind Of Destruction Is Quantitively Proved By Ultrasonic Measurements.		

Budget and duration

Phase	Budget(Meuro)	Duration (Months)
Definition phase	0.21	12
Full Exploitation	1.27	84
Implementation phase	0	12
Total	**1.48**	**108**

Member contribution

Member	Contribution	Position	Since
Germany	**30.00%**	**Notified Finished**	**01-AUG-2000**
Austria	20.00%	Notified Finished	01-AUG-2000
Greece	20.00%	Notified Finished	01-AUG-2000
Italy	10.00%	Notified Finished	01-AUG-2000
Russian Federation	10.00%	Notified Finished	01-AUG-2000
Sweden	10.00%	Notified Finished	01-AUG-2000

Participants

Company	Country	Type	Role
Mut - Institut Fuer Geologie (Iaag) Technische Universitaet Muenchen	**Germany**	**University**	**Main**
University Of Patras/Chemical Engineering Faculty	Greece	University	Partner
Goeteborg University/Department Of Inorganic Chemistry	Sweden	University	Partner
Institut Fuer Chemie Und Biologie Des Meeres (Icbm) Carl-Von-Ossietzky Universitaet Oldenburg	Germany	University	Partner
Hochschule Fuer Angewandte Kunst In Wien Institut Fuer Silikatchemie Und	Austria	University	Partner

Participants

Company	Country	Type	Role
Archaeometrie (Isca)			
Goeteborg University/Institute Of Conservation Gmv-Goeteborg Centre Of Environment And Sustainability	Sweden	University	Partner
Stockholms Historiska Museum	Sweden	SME	Partner
Stockholms Historiska Museum/Centr. Board Of Nat.Antiquities	Sweden	Governm./Nat. Admin.	Partner
Ibach Steinkonservierung Gmbh	Germany	SME	Partner
Bayerisches Landesamt Fuer Denkmalpflege (Muenchen)	Germany	Governm./Nat. Admin.	Partner
C.N.R. - C. S. Deperimento E Conservazione Opere D'Arte	Italy	Research Institute	Partner
Russian Scientific Research Institute Of Restoration	Russian Federation	Research Institute	Partner
Universita Di Messina/Istituto Di Microbiologia	Italy	University	Partner
Labor Koehler F. Bauwerksdiagnose, Archeometrie U. Geophysik	Germany	SME	Partner
Universitaet Innsbruck/Inst.Fuer Mineralogie U.Petrographie	Austria	University	Partner
Konservierung U.Denkmalpflege Consulting Herrn Simon U.Herrn	Germany	SME	Partner
C.N.R. - Centro C.N.R. Gino Bozza	Italy	Research Institute	Partner
Russian Academy Of Sciences/Institute Of Physical Chemistry	Russian Federation	Research Institute	Partner
Lindholm Restaurator Ab	Sweden	SME	Partner
Universita Di Venezia/Dipartim. Di Storia Dell Architettura	Italy	University	Partner
Wigom	Germany	SME	Partner
Universita Di Modena/Department Of Earth Science	Italy	University	Partner

2. Project outline

Project description

Marbles in the open air are greatly affected by environmental conditions. The loss of polishing, an increasing surface roughness, sugar-like sanding off and contour scaling are the main damage phenomena which can be observed on statues and building decorations. The most serious damage, however, is a complete disintegration of the marble structure which can cause the collapse of a whole statue. This risk, which is particular for marble, cannot be detected by visual inspection.
It is generally accepted that physical, chemical and biological processes are interacting. From the biological point of view, pitting lichens can be responsible for rapid marble disintegration. The most important physical parameter seems to be the anisotropic thermal expansion of calcite crystal. Sulphur dioxide is obviously the most aggressive chemical agent as it influences the Zeta-Potential of the calcite surface and the contact forces between the calcite grains.
Most conservation treatments on marble are carried out using acrylic resins or mixtures of them with silicon cmpounds. A few marbles have also been treated with ethyl silicate. In GERMANY, however, many marble statues or tombstones have been treated with the "PMMA Full Impregnation Method" ("IBACH Method").
The goals of the project are to study the mode and extent of deterioration processes and develop specific materials and methods of conservation. A special interest will be devoted to pilot object investigations in member countries to establish an inventory of state-of-the-art marble objects. Another main project part is to start the outdoor exposure programme. To this end, the following investigations are in progress or being planned:
* Investigations on deterioration processes:
Geological and mineralogical investigations by visual microscopy, scanning electron microscope (SEM) and energy dispersive X-ray analysis (EDX)
Investigations on the influence of airborne fly ash particles on the sulphatation rate
Determination of the Zeta-Potential and its changes during weathering
Measurements of the marble strength with ultrasonic methods.
* Test Methods:
Laboratory exposure of marbles in weathering chambers under artificially polluted atmosphere
Outdoor exposure of marbles at different sites in Europe with significantly different climates.
* Conservation Investigations:
Test application of tensides with and without modified silicon organic or acrylic chemicals
Study of biological interactions with protective agents.
The project has been running since 1991. The proceedings of annual meetings have been regularly published.
Note on timescale:
Start: 1990
Initial phase: 1990/1
Main project phase beginning 1991

Proposed duration min. 3 years.
1990: Final definition of the programme
Selection of marble types and objects
Workshop and report I.
1991: Outdoor exposition of samples
Laboratory weathering tests on samples
Analytical work on samples and objects
Workshop and report II.
1992: Analytical work continuing
Laboratory and outdoor exposure tests continuing
Test application of conservation products
Workshop and report III.
1993: Analytical work continuing
Laboratory and outdoor exposure tests continuing
Measurements on pilot objects
Workshop and report IV.
1994: Analytical work continuing
Laboratory and outdoor exposure tests continuing
Measurements on pilot objects
Workshop and report V.
1995: Analytical work continuing
Laboratory and outdoor exposure tests continuing
Measurements on pilot objects
Workshop and report VI.
1996: Analytical work continuing
Laboratory and outdoor exposure tests continuing
Measurements on pilot objects
Workshop and report VII.
1997: Analytical work continuing
Laboratory and outdoor exposure tests continuing
Measurements on pilot objects
Workshop and report VIII.
1998: Analytical work continuing
Laboratory and outdoor exposure tests continuing
Measurements on pilot objects
Workshop and report IV.

Technological development envisaged

Refinement of ultrasonic measurements and their interpretation with respect to the state of deterioration of marble.
Test applications of tensides silica sols and artificial resins for marble consolidation.
Refinement of the quality control in the "PMMA Full Impregnation Conservation Process".
Outdoor exposure programme to study the steps of marble deterioration under different climatic conditions.

Markets application and exploitation

The results obtained will be used in the practical restoration of marble monuments. The ultrasonic methods will be a useful tool to decide on conservation necessities and accompanying measures to protect marble. The application of the results will be of interest to museums, antiquities and monument authorities as well as freelance restorers.
Initial exploitation will be carried out in every country by the Local Authority in charge of carrying out the

practical conservation of the selected monuments. Patent applications and use will remain the participant's own.

Project codes

BSI

BA/BK	measurement
BNW	acoustic testing
CPU	ultrasonics
EDH.LP	marble
R	construction
RXH.D	stone
ZO	history
ZV/ZY	culture
ZW	arts

NACE

7310	Research and experimental development on natural sciences and engineering
7420	Architectural and engineering activities and related technical consultancy
9252	Museum activities and preservation of historical sites and buildings

3. Main participant

Company	**Mut - Institut Fuer Geologie (laag) Technische Universitaet Muenchen** Luisenstrasse, 37 80333 Muenchen Germany Tel +49 89 5303-0 Fax +49 89 5203 286
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Organisation type	University
Participant role	Main

Contribution to project

Project management: meeting organisation, publication of proceedings, contacts with members. Chemical investigation on weathered marbles, test application of surfactants, ultrasonic measurements, run of the exposure site in Munich.

Expertise

University Institute with a long tradition of investigation into the deterioration and conservation of natural stones. All their instrumental equipment relevant for natural stone investigation will be made available. Cooperation with the BAVARIAN STATE CONSERVATION OFFICE.

4. Partner

Company	**University Of Patras/Chemical Engineering Faculty** University Campus, 261 10 Patras Greece Tel +30 610 997 563 Fax +30 610 993 255
Contact	**Prof. Petros G. Koutsoukos** Tel +30 610 997 265 Fax +30 610 993 255
Organisation type	University
Participant role	Partner

Contribution to project

Investigation into the kinetics of dissolution and precipitation processes of calcite under different pH and ionic strength conditions.

Expertise

University Institute with considerable experience in the investigation of chemical processes. All their instrumental equipment for relevant natural stone investigation will be made available.

4. Partner

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Organisation type University
Participant role Partner

Contribution to project

Expertise

4. Partner

Company

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Organisation type University
Participant role Partner

Contribution to project

Investigation into the biological colonisation of marbles mainly by chemo-organotropic bacteria, lichens and funghi.

Expertise

University Institute with more than 20 years' experience of investigations into the biological infection of stones. All their instrumental equipment relevant to natural stone investigation will be made available.

4. Partner

Company **Hochschule Fuer Angewandte Kunst In Wien Institut Fuer Silikatchemie Und Archaeometrie (Isca)**
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Organisation type University
Participant role Partner

Contribution to project

Artificial weathering of marble by physical and chemical methods in a weathering chamber. Run of the exposure site in Vienna. The project is supported by the AUSTRIAN NATIONAL RESEARCH FUND.

Expertise

University Institute with a tradition of investigation into deterioration and conservation of natural stone. Cooperation with the AUSTRIAN NATIONAL CONSERVATION OFFICE. All instrumental equipment relevant for natural stone investigations is available.

4. Partner

Company

Goeteborg University/Institute Of Conservation
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Organisation type University
Participant role Partner

Contribution to project

Investigations on influence of airborne fly ash particles on the rate of sulphatation. Artificial weathering of marble in laboratory chambers and chemical analysis of exposed marble samples. Run of the exposure site in Goeteborg.

Expertise

University Institute with considerable experience in the research and teaching of conservation techniques. All their instrumental equipment relevant to natural stone investigation will be made available.

4. Partner

Company

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Contact

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Organisation type SME
Participant role Partner

Contribution to project

Execution of practical conservation tests. Application of cleaning methods, impregnation of marbles, test of repair and filling mortars for marble.

Expertise

Private company with more than 15 years' experience in stone conservation.

4. Partner

Company **Stockholms Historiska Museum/Centr. Board Of Nat.Antiquities**
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Organisation type Governm./Nat. Admin.
Participant role Partner

Contribution to project

Run of the exposure site in Stockholm. Investigations into the weathering of Swedish marble monuments.

Expertise

National Authority for the care of monuments. Stone laboratory and workshop are affiliated to it. More than 20 years' experience in practical stone conservation.

4. Partner

Company	**Ibach Steinkonservierung Gmbh** Tannenstrasse, 8 96120 Bischberg Germany Tel +49 951 680 36 Fax +49 951 680 39
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Organisation type	SME
Participant role	Partner

Contribution to project

Execution of the "PMMA Full Impregnation" of marble, investigation into impregnated marble objects with ultrasonic measurements to specify the quality status of the treatment.

Expertise

Private company with 20 years' experience in the PMMA treatment of stone. Worldwide IBACH is the only firm able to run the full impregnation in a combined vacuum-pressure process.

4. Partner

Company	**Bayerisches Landesamt Fuer Denkmalpflege (Muenchen)** Hofgraben, 4 80539 Muenchen Germany Tel +49 89 2114-0 Fax +49 89 2114 300
Contact	**Prof. Rolf Snethlage** Tel +49 89 2114 321 Fax +49 89 2114 300
Organisation type	Governm./Nat. Admin.
Participant role	Partner

Contribution to project

Expertise

National authority for the care of monuments. Workshop for stone restoration and physico-chemical laboratory are affiliated to it. Have been carrying out active research on stone conservation for 20 years. Laboratory equipment will be made available to the project.

4. Partner

Company **C.N.R. - C. S. Deperimento E Conservazione Opere D'Arte**
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Organisation type Research Institute
Participant role Partner

Contribution to project

Corresponding member.

Expertise

4. Partner

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Organisation type Research Institute
Participant role Partner

Contribution to project

Test application and practical conservation on marbles in Moscow. Management of the exposure site in Moscow.

Expertise

National Authority for the preservation of monuments. Cooperation with the Institute of Physical Chemistry of THE ACADEMY OF SCIENCE.

4. Partner

Company **Universita Di Messina/Istituto Di Microbiologia**
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Organisation type University
Participant role Partner

Contribution to project

Investigation into the biological colonisation of marbles mainly by chemo-organotrophic bacteria, lichens and funghi. Run of the exposure site in Messina.

Expertise

University Institute with considerable experience in the investigation of the biological infection of stones. All their instrumental equipment relevant to biological investigations into natural stone will be made available.

4. Partner

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Organisation type SME
Participant role Partner

Contribution to project

Ultrasonic transmission measurements on pilot objects.

Expertise

Private company with considerable experience in stone expertise. Specialised in ultrasonic techniques.

4. Partner

Company **Universitaet Innsbruck/Inst.Fuer Mineralogie U.Petrographie**
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Organisation type University
Participant role Partner

Contribution to project

Comparison of marble weathering under natural outdoor conditions in quarries and on selected monuments in AUSTRIA. The main interest is focused on alpine marbles from Tirol.

Expertise

University institute with considerable experience in natural stone investigations. All their instrumental equipment relevant for natural stone investigation will be made available.

4. Partner

Company

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Organisation type SME
Participant role Partner

Contribution to project

Non-destructive measurements on the marbles at the sites in different countries (round travel to the 7 exposure sites). Surface roughness, ultrasonic transmission, colour measurement, gloss measurement.

Expertise

Private company with considerable experience in stone expertise.

4. Partner

Company

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Organisation type Research Institute
Participant role Partner

Contribution to project

Expertise

4. Partner

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Organisation type Research Institute
Participant role Partner

Contribution to project

Expertise

4. Partner

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Organisation type SME
Participant role Partner

Contribution to project

Expertise

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Organisation type University
Participant role Partner

Contribution to project

Corresponding member

Expertise

4. Partner

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Organisation type SME
Participant role Partner

Contribution to project

Note: has replaced the UNIVERSITY OF HAMBURG.

Expertise

Formerly NIMBUS.

4. Partner

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Organisation type University
Participant role Partner

Contribution to project

Expertise