EUREKA PROJECT E!367 - EUROCARE GRANITIX

1. General description

Project	E! 367 - EUROCARE GRANITIX	**Status**	Finished - 10-APR-1995
Title	**Studies On Conservation Of Granitic Rocks. Application To The Megalithic Monuments Of The Iberian Penisula**		
Class	Sub-Umbrella	**Technological area**	Environment
Start date	01-APR-1991	**End date**	01-JAN-1995
Duration	45 months	**Total cost**	3.67 Meuro
Partner sought	No		
Summary	Contribute To A Better Knowledge Of The Degradation Phenomena And Conservation Procedures Of Granitic Rocks In General And Megalithic Monuments In Particular.		

Budget and duration

Phase	Budget(Meuro)	Duration (Months)
Total	**3.67**	**45**

Member contribution

Member	Contribution	Position	Since
Portugal	**73.00%**	**Notified Finished**	**10-APR-1996**
Spain	27.00%	Notified Finished	10-APR-1996
European Union	.00%	Notified Finished	10-APR-1996

Participants

Company	Country	Type	Role
Laboratorio Nacional De Engenharia Civil	**Portugal**	**Research Institute**	**Main**
Matesica - Materiais Sinteticos Para Construcao S.A.	Portugal	Large company	Partner
The European Commission - Research Dg	Belgium	Governm./Nat. Admin.	Funder
Wacker Quimica Portugesa S.A.	Portugal	Large company	Partner
Uo - Departamento De Geologia (Dg) Universidad De Oviedo	Spain	University	Partner
Irc - Instituto Benta Da Rocha Cabral/Faculdade De Ciencias	Portugal	University	Partner
Inst.Port.Do Patrimonio Cult./Arquitectonico E Arqueologico	Portugal	Governm./Nat. Admin.	Partner
Instituto Tecnologico E Nuclear	Portugal	Research Institute	Partner
Iict - Centro Da Cristofografia E Mineralogia (Ccm) Instituto De Investigacao Cientifica Tropical	Portugal	Research Institute	Partner

Participants

Company	Country	Type	Role
Universidade De Evora/Departamento De Fisica	Portugal	University	Partner
Sika - Industria Quimica S.A. (Porto)	Portugal	Large company	Partner

2. Project outline

Project description

A - Objective:
The aim of this research project is to contribute to a better knowledge of the degradation phenomena and of the conservation procedures of granitic rocks, in general, and to the specific aspects related to the conservation of megalithic monuments in particular.
B - Scope:
In the Iberian Peninsular there are a very large number of monuments made of granitic rocks. Megalithic monuments, castra and other prehistoric and proto-historic monuments, Roman structures, cathedrals, churches and an immense number of civil buildings constitute a vast heritage which needs to be preserved. Granitic rocks present several characteristics that give them some pecularities and reduce, or even nullify, the possibilities of extrapolating to them, knowledge concerning other types of rocks, such as limestones and sandstones, more often the object of interest by the international scientific community.
Granitic rocks are polimineralic and their constituents have very physical and chemical properties. Their behaviour as regards weathering is distinct as well. Granitic rocks, when fresh, are compact, highly resistant, and have low porosity and permeability, but they undergo a significant decrease in quality, for increments of these two parameters, even if they are small. Granitic rocks are mainly composed of quartz and feldspars (alkaline and/or plagioclase) and may contain significant amounts of other minerals. Different grain sizes lead to differences in rock behaviour and small amounts of secondary minerals may accelerate the degradation of these rocks. Voids are mainly of the fissure type and their role in reducing permeability is much more efficient than a similar volume of voids of the pore type. Selection of treatments for granitic rock is very difficult because of its low porosity and permeability greatly hinder the penetration of treatment products. Assessment of treatment efficacy is also difficult, owing to the small quantities of products that can be absorbed and to their distribution through extremely small voids, which demands very accurate and powerful testing equipment to detect and characterize the products. Assessment of treatment durability raises some intricate problems in any type of rock. Several aspects are involved such as: chemical and mechanical properties of the treatment products, stability in time, of their relevant physical properties, as well as properties of the new composite material made up of the rock plus the treatment product. Accelerated ageing tests in laboratory conditions, though useful, have not been sufficient to overcome the scarcity of experience gathered with treatment products in their still short existence. Direct involvement of industrial partners is considered very important. Supply of treatment products and cooperation in the development of the new formulations are some key issues coming coming from their participation. For PORTUGAL this has a specific interest because conservation practice is quite incipient and there is a great difficulty in obtaining conservation products. In the course of the project some benefits are

expected to come out of it for the conservation practitioners, taking into account that research support for these specialised teams is almost absent in PORTUGAL. Although in a less critical manner, the situation in SPAIN as regards the conservation industry is also unsatisfactory.
C - Main points of interest:
Several useful contributions are expected to come from this project both for the preservation of megalithic monuments and, in a broader sense, for other monuments built with granitic rock. For the specific case of megalithic monuments the following points of interest should be stressed:
1. Petrographic and mineralogic study of rocks in these monuments
2. Identification of degradation pathologies and their relationships, with place of occurrence, rock properties, environmental conditions, etc.;
3. Identification of rock weathering mechanisms particularly important in these pathologies;
4. Selection of conservation methods adequate to these monuments;
5. Selection of the most promising products for consolidating granitic rock;
6. Characterization of the efficacy of some available treatment products. Special emphasis should be attached to the following:
* study of the properties of the rock plus product composite under treatment and of interfaces created by the introduction of a foreign material;
* assessment of the stability in time of those properties;
7. control and monitoring of conservation procedures.
In a broader sense, and with relevance to all the cultural heritage built of granitic rock, the following points of interest of this project should be stressed:
- improving knowledge about granitic rock, in particular as regards porous space and alteration minerals;
- obtaining test equipment and procedures indispensable for any detailed study of the numerous problems related to the conservation of the monuments built with granitic or other types of rock;
- better mastering of conservation techniques, in particular stone consolidation treatments;
- developing and applying methodologies for the stdy of the biodegradation of rock materials.

Technological development envisaged

Although more detailed programmes may be necessary for some items, a certain number of activities can already be pointed out in order to allow an assessment of the area and scope of the present project.
(I) General activities
(a) - Bibliographic search on the fundamentals of granitic rock weathering especially when used in monuments. Survey and collection of information on study and testing methods. Preparation of a report with a synthesis of these matters.
b) - field survey of the main megalithic monuments in Alentejo and Galicia. Analysis of the state of conservation, identification and characterization of local

environmental conditions. Selection of those monuments to be studied in detail, taking into account the objectives of the research programme, and the interest of the supervising entities (IPPC, in PORTUGAL, JUNTA AUTONOMA DE GALICIA, in SPAIN). Preparation of a report with the results of this phase.
c) - Collecting of data on the degradation pathologies. Their types, morphology, place of occurrence in the monument and relationships with environmental weathering factors, mineral composition and rock texture.
d) - sampling in the monuments. The samples to be obtained will aim at characterizing the weathered rock, at the identification of the weathering mechanisms and at testing some conservation products. Weathering products such as scales, plates and particles as well as efflorenscences will be collected. Foundation terrains will also be sampled. Biodegradation agents will be the object of the specific sampling procedures.
e) - complementary sampling. Some sampling campaigns will be carried out in quarries, whenever possible, those with rocks similar to to those of the monuments. The main objective is to obtain enough material for tests that need large amounts of material and for development of a "sample bank" for comparative studies, namely for testing conservation products.
f) - laboratory research. A vast programme of laboratory studies is envisaged. In general terms it aims at characterizing rock materials and their weathering products, at identifying weatering mechanisms and their casuses and at testing some conservation products for assessing their adequacy for this type of rock, improvement of of the material characteristics and their harmlessness and durability. Because Portugueuse experience on biodegradation is very small, a comprehensive programme on this subject will be included in the project.
(II) Specific Activities
Although this is not intended as a detailed research programme, some specific activities are enumerated here to give a better insight into the scope of the project.
a) - studies on weathering of feldspars and ferromagnesian minerals, particularly as regards evolution of their porous space and formation of clay minerals, and evolution of their specific surfaces during the weathering process.
b) - crystallographic and chemical transformations in biotite during the weathering process and their influence on rock properties.
c) - Analysis of pore size distributions and research on the genesis of porous space.
d) - characterization of rock fissuration. Selection, and application of adequate methods for description, quantification and visualization of fissures. Impregnation and colouring procedures.
e) - Physical characterization of rock materials and research on the most significant parameters for explaining water movement through those materials as well as migration and crystallization of salts.
f) - Identification and characterization of weathering mechanisms from biotic origin. Selective laboratory tests on the main mineral components of granitic rock.
g) - testing of some treatment products on weathered and non-weathered rocks, aiming at characterizing their efficacy and durability. The following aspects, among others, will be dealt with:

- assessment of the penetration capacity of products intended for several weathering stages of rock materials;
- study of modifications in rock properties namely in porosity, capillarity and permeability;
- characterization of the strength of impregnated rocks;
- studies on treatment durabiltiy; accelerated ageing tests on treated and non-treated rocks for several aggressive test conditions;
- in situ pilot study under controlled conditions and taking into account the importance of the monument and the potential risk of the treatments to be applied; assessment of the efficacy, harmfulness and durability of some biocide treatments.
- assessment of the efficacy and harmfulness of some cleaning procedures for granitic rocks.

Markets application and exploitation

The results to be obtained will find direct application on the conservation of monuments or any other type of man-made construction built on granitic rocks. Megalithic monuments will be dealt with in some more detail as a paradigmatic situation. Industry will be involved in this project, mainly in the points concerned with conservation procedures and with treatment products. Available products as well as possible new formulations will be tested.
The scientific matter will be publicized by the research team, due reference being made to the authorship.
Technological achievements, namely on any improvement on conservation products, will be exploited by the industrial partner concerned.

Project codes

BSI

BKK	meteorological measurement
EDG.EB	granite
RXH.D	stone
ZO	history
ZV/ZY	culture

NACE

3. Main participant

Company	**Laboratorio Nacional De Engenharia Civil** Avenida Do Brasil, 101 1799 Lisbon Portugal Tel +351 21 88 21 31 Fax +351 21 89 76 60 www.lnec.pt
Contact	**Eng. Jose Delgado Rodrigues** Tel +351 21 848 21 31 Fax +351 21 847 81 87 delgado@lnec.pt
Organisation type	Research Institute
Participant role	Main

Contribution to project

20 Million Escudos with personnel.

Expertise

1. J. Delgado Roderigues (Project Coordinator): - Geologist, Senior Research Officer - President of the PETROGRAPHY Group of the INCOMOS Stone Committee - Member of the International Permanent Scientific Committee for the Organisation of Congresses on Stone Conservation - Member of the Scientific Advisory Committee of the European Symposium (Bologna 1989) - Member of the Portuguese Group for the Study of Stone Conservation. 2. Elda de Castro: - Chemical Engineer, Principal Research Officer - Member of the Portuguese Group for the Study of Stone Conservation 3. F. Telmo Jeremias: - Geologist, Trainee Research Officer. •

4. Partner

Company	**Matesica - Materiais Sinteticos Para Construcao S.A.** Estrada Da Abobada, Abobada, 2775 Parede Portugal Tel +351 21 444 0138 Fax +351 21 444 0152
Contact	**Dr. George Jauker** Tel +351 21 444 01 38 Fax +351 21 444 01 52

Organisation type Large company
Participant role Partner

Contribution to project

Expertise

4. Partner

Company

The European Commission - Research Dg
Rue De La Loi, 200
1049 Bruxelles
Belgium

Tel +32 2 299 5827
Fax +32 2 296 7026

www.cordis.lu/

Contact

Mr. Nicholas N. Newman

Tel +32 2 295 5976
Fax +32 2 296 4249

nicholas.newman@cec.eu.int

Organisation type Governm./Nat. Admin.
Participant role Funder

Contribution to project

This project is partly funded by the CEC's STEP programme.

Expertise

4. Partner

Company

Wacker Quimica Portugesa S.A.
Torre 2, Porta 7, Avenida Duarte Pacheco,
1000 Lisbon
Portugal

Tel +351 21 69 13 43
Fax +351 21 65 35 37

Contact	**(Contact Not Available)**
	Tel Fax
Organisation type	Large company
Participant role	Partner

Contribution to project

The cost of conservation products, expenses with its own personnel and the work carried out in its own laboratories.

Expertise

4. Partner

Company	**Uo - Departamento De Geologia (Dg) Universidad De Oviedo** (Not Available), 33000 Oviedo Spain
	Tel +34 985 103 000 Fax +34 985 233 911
Contact	**Prof. Rosa Esbert**
	Tel Fax
Organisation type	University
Participant role	Partner

Contribution to project

Rosa Esbert - Geologist.

Expertise

4. Partner

Company	**Irc - Instituto Benta Da Rocha Cabral/Faculdade De**

Ciencias
Cc Bento Da Rocha Cabral, 14
1200 Lisbon
Portugal

Tel +351 21 65 96 28
Fax +351 21 759 9404

Contact **Dr. Paola Romao**

Tel +351 21 65 96 28
Fax

Organisation type University
Participant role Partner

Contribution to project

Dra. Paola Romao - Chemist.

Expertise

4. Partner

Company **Inst.Port.Do Patrimonio Cult./Arquitectonico E Arqueologico**
Palacio Do Vimioso, Largo Marques De Marialva,
7000 Evora
Portugal

Tel +351 266 221 38
Fax +351 266 221 26

Contact **(Contact Not Available)**

Tel
Fax

Organisation type Governm./Nat. Admin.
Participant role Partner

Contribution to project

1. Adilia Alarcao - Archaeologist 2. Dr. Rui Parreira - Archaeologist.

Expertise

4. Partner

Company	**Instituto Tecnologico E Nuclear** Estrada Nacional, 10 2685 Sacavem Portugal Tel +351 21 955 0021 Fax +351 21 955 0117
Contact	**Dra. Isabel Prudencio** Tel Fax
Organisation type	Research Institute
Participant role	Partner

Contribution to project

Expertise

4. Partner

Company	**Iict - Centro Da Cristofografia E Mineralogia (Ccm) Instituto De Investigacao Cientifica Tropical** Alameda Afonso Henriques, 41 1800 Lisbon Portugal Tel +351 21 847 6596 Fax +351 21 363 1460
Contact	**Dra. Ma. Ondina Figueiredo** Tel Fax
Organisation type	Research Institute
Participant role	Partner

Contribution to project

Dra. Ma. Ondina Figueiredo

Expertise

4. Partner

Company	**Universidade De Evora/Departamento De Fisica** Largo Dos Colegiais, 2 7000 Evora Portugal Tel +351 266 224 93 Fax +351 266 311 88
Contact	**Prof. Rui Namorado Rosa** Tel Fax
Organisation type	University
Participant role	Partner

Contribution to project

Expertise

4. Partner

Company	**Sika - Industria Quimica S.A. (Porto)** Campo Do Monte, Rua De Santerem, 113 4401 Vila Nova De Gaia Portugal Tel +351 22 370 1850 Fax +351 22 370 2022
Contact	**Eng. Anibal Fonseca** Tel Fax

Organisation type Large company
Participant role Partner

Contribution to project

Expertise