



## DELIVERABLE D6.9

### Document details

WP6 – Dissemination Activities	
Task 6.2 – Dissemination of Technical Activities	
Task Leader: NTUA / WP Leader: NTUA	
Deliverable No.	6.9
Deliverable Title	Publication in Specialized Journals
Written By	NTUA
Approved by	All Partners
Status	Definitive
Date	29/02/2016 (M30)
<b>Dissemination Level</b>	<b>PUBLIC</b>

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#### VERSION CONTROL

Version	Date	Written by	Checked by	Approved by
V1.0	15.10.14	NTUA	CEINNMAT	CEINNMAT
V1.1 (*)	29.11.14	NTUA	CEINNMAT	CEINNMAT
Final	29.02.16	NTUA	CEINNMAT	CEINNMAT

Table 1. Reviews

## INDEX

1	INTRODUCTION .....	2
2	PUBLICATION IN SPECIALIZED CONFERENCES, EVENTS, FAIRS.....	3
3	APPENDIX I (EGU 2016) .....	6
4	APPENDIX II (AMPERE 2015) .....	7

## 1 INTRODUCTION

Dissemination actions aiming to spread the STEP project concept and objectives as well as its specific technical results in conferences, fairs, events and scientific journals are presented in this deliverable. The selected conferences – events target both technical and general public. Papers addressing objectives and technical results of the project were presented in conferences focusing on both material and industrial applications with respect to highlighting the project's eco – innovations announcing its results and ensuring their wide diffusion in the respectively associated scientific and industrial communities.

## 2 PUBLICATION IN SPECIALIZED CONFERENCES, EVENTS, FAIRS

Partners involved in the STEP project consortium have participated presenting technical results based on the project's activities in the following conferences, events and fairs.

### [1] EGU 2016 (European Geosciences Union General Assembly 2016)

The EGU 2016 was held in Vienna, Austria, between April 17-22, 2016. 13650 scientists from 109 countries participated to the conference according to the official site ([www.egu2016.eu/](http://www.egu2016.eu/)). It should be noted that EGU, the European Geosciences Union, is Europe's premier geosciences union, dedicated to the pursuit of excellence in the Earth, planetary, and space sciences for the benefit of humanity, worldwide. The title of the presentation by CEINNMAT on behalf of the STEP project was: **"Dielectric non destructive testing for rock characterization in natural stone industry and cultural heritage"** and the authors are *Angel M. López-Buendía, Beatriz García-Baños, M. Mar Urquiola, José D. Gutiérrez, and José M. Catalá-Civera* from CEINNMAT and UPVLC. The first and last slides of a presentation related to this paper are depicted in Fig. 1 highlighting also the STEP project acknowledgement. The abstract of the paper is quoted in [Appendix I](#).

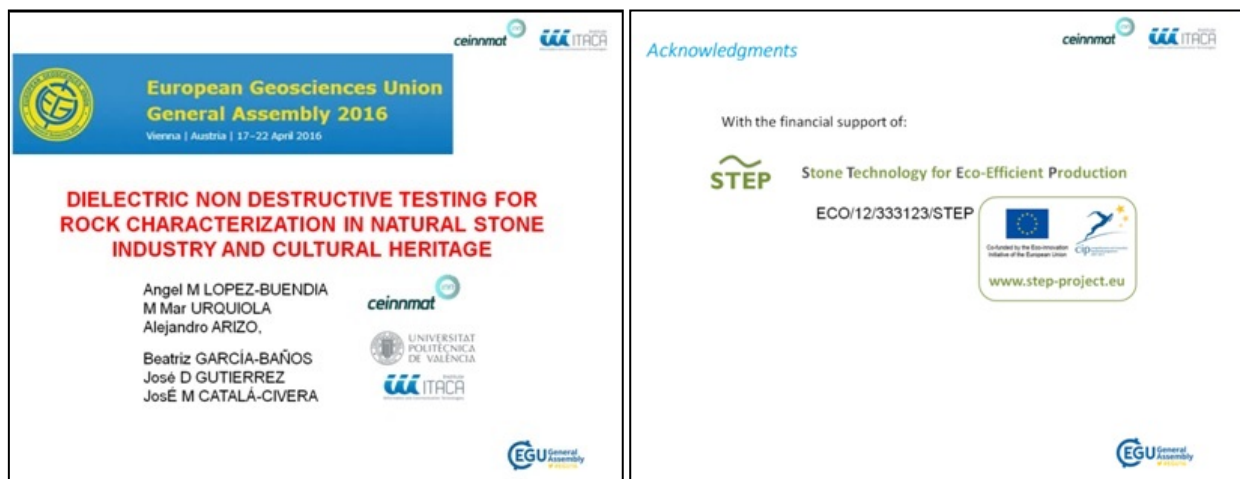


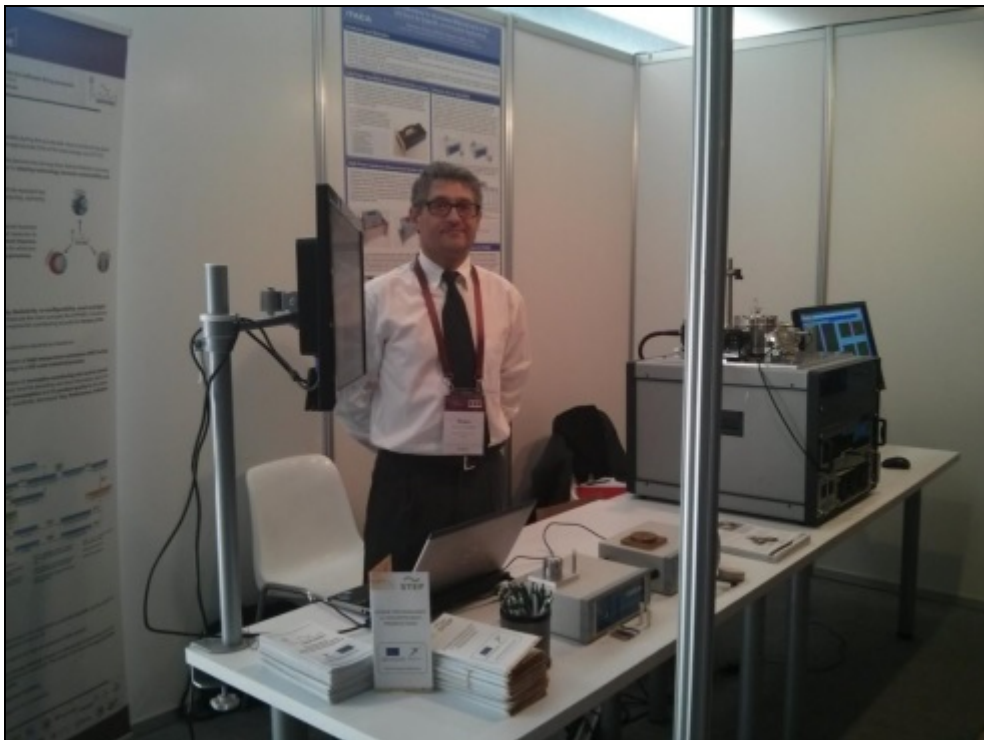
Fig. 1: Cover and last slide of the EGU 2016 general assembly.

### [2] AMPERE 2015 (15th International Conference on Microwave and High Frequency Heating)

The AMPERE 2015 was held in Krakow, Poland, between September 14-17, 2015 ([www.ampere.pk.edu.pl](http://www.ampere.pk.edu.pl)). It was organized by the Association for Microwave Power in Europe for Research and Education, which is a "European" non-profit association devoted to the promotion of microwave and radio frequency heating techniques for research and industrial applications. The interests of the association are very wide and encompass academia, commerce, domestic as well as industrial applications. The title of the presented paper is: **"Dielectric measurement for rock characterization and microwave heating prediction"** (Book of Abstracts: p. 102) and the authors are *Angel M. López-Buendía, M. Mar Urquiola, Alejandro Arizo, Beatriz García-Baños, Pedro Plaza Gonzalez and José M. Catalá-Civera* from CEINNMAT and UPVLC. The first and last pages of the paper are depicted in [Appendix II](#) highlighting also the STEP project acknowledgement.

### [3] ECERs 2015 (14th International Conference of the European Ceramic Society Conference)

The 14th Conference of the European Ceramic Society took place in Toledo, Spain, from the 21st to the 25th of June 2015. It was organized by the auspices of the Spanish Ceramic and Glass Society (Sociedad Española de Cerámica y Vidrio, SECV). According to the conference's official website (<http://www.ecers2015.org/>), the ECerS Conference is organised every two years and is considered to be an important meeting point for scientists, students and industrialists willing to have a direct access to one of the largest community of international experts of ceramic science and technology. UPVLC participated in the conference as an exhibitor and disseminated STEP project by offering STEP leaflets and merchandise in a specially organized stand (Fig. 2)



**Fig.2:** STEP project dissemination in ECERs 2015.

### [4] 18th European Forum on Eco-innovation (Boosting Competitiveness and Innovation - 2015)

CEINMAT attended the 18th European Forum on Eco-innovation held in Barcelona in May 20-21, 2015. This Forum was aimed at exchanging ideas towards strengthening competitiveness and innovation, in particular for SMEs, through environmental labelling, management and information.

### [5] Greek Researcher's Night – 2014

NTUA participated in the Greek Researcher's night held in Athens (the "Athens section") in September 25, 2014, as an exhibitor and disseminated STEP project by presenting its official poster in a specially organized stand (Fig. 3). The Greek Researcher's Night is an annual awareness campaign targeting the general public and ensuring maximum visibility of the events through its network of collaborators from universities and research centres to popular media outlets.



**Fig.3:** STEP project dissemination in Greek Researcher's Night 2014.

It should be noted that the publication of STEP technical results in specialized scientific journals is still an open subject and within the next months more papers containing results obtained during the project's lifetime might be submitted with respect to being published. CEINNMAT and UPVLC in particular are preparing a paper due to be submitted soon in one of the following scientific journals (the list contains several indicative scientific journals covering topics relevant to STEP objectives):

- Journal of Cleaner Production
- Construction and Building Materials
- International Journal of Rock Mechanics and Mining Sciences
- Applied Thermal Engineering
- International Journal of Mineral Processing
- Journal of Materials Processing Technology
- Journal related to energy efficiency in geomaterials
- Progress in Organic Coatings
- Composites Part B: Engineering



### 3 APPENDIX I

#### EGU\_abstract

Geophysical Research Abstracts  
Vol. 18, EGU2016-18173, 2016  
EGU General Assembly 2016  
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## Dielectric non destructive testing for rock characterization in natural stone industry and cultural heritage

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EGU 2016 European Geosciences Union, General Assembly 2016

ERE6.3 Geomaterials in construction: resources, properties, performance, and environmental interactions.

Dielectric non destructive testing for rock characterization in natural stone industry and cultural heritage

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**Keywords:** complex permittivity, petrography, rock processing, cultural heritage, portable dielectric measurement, non destructive techniques

Dielectric constant measurement has been used in rocks characterization, mainly for exploration objective in geophysics, particularly related to ground penetration radar characterization in ranges of 10 MHz to 1 GHz. However, few data have been collected for loss factor.

Complex permittivity (dielectric constant and loss factor) characterization in rock provide information about mineralogical composition as well as other petrophysic parameters related to the quality, such as fabric parameters, mineralogical distribution, humidity.

A study was performed in the frequency of 2,45GHz by using a portable kit for dielectric device based on an open coaxial probe. In situ measurements were made of natural stone marble and granite on selected industrial slabs and building stone. A mapping of their complex permittivity was performed and evaluated, and variations in composition and textures were identified, showing the variability with the mineral composition, metal ore minerals content and fabric.

Dielectric constant was a parameter more sensible to rock forming minerals composition, particularly in granites for QAPF-composition (quartz-alkali feldspar-plagioclases-feldspathoids) and in marbles for calcite-dolomite-silicates. Loss factor shown a high sensibility to fabric and minerals of alteration.

Results showed that the dielectric properties can be used as a powerful tool for petrographic characterization of building stones in two areas of application: a) in cultural heritage diagnosis to estimate the quality and alteration of the stone, an b) in industrial application for quality control and industrial microwave processing.



## 4 APPENDIX II

### AMPERE2015\_paper, first page

*15<sup>th</sup> International Conference on Microwave and High Frequency Heating  
AMPERE 2015, Krakow, Poland, September 14-17, 2015*

#### **DIELECTRIC MEASUREMENT FOR ROCK CHARACTERIZATION AND MICROWAVE HEATING PREDICTION**

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**Keywords:** microwave, dielectric measurement, rock processing, petrography.

#### **INTRODUCTION**

Dielectric constant characterization has been used in rocks mainly for exploration objective in geophysics, particularly related to ground penetration radar characterization in ranges of 10 MHz to 1 GHz. However, few data has been collected accurately of dielectric constant and loss factor with the compositional and spatial variability in the rocks [1]. In industry microwave on rocks and mineral processing [2] is becoming more interest due to many advantages as efficiency, or selective heating and effect in mineral compounds during microwave treatment, in processes such as drying [3], comminution [4,5,6], metallurgy [7], drilling [8,9], natural stone processing, between others. Nevertheless, there are not extensive industrial applications related and according with this potentiality, which can be related to lack of knowledge, equipment design specifically for rocks and applications of added value.

In natural stone processing the use of polymers for reinforcement [10] show two very different materials with very different dielectric properties, design of microwave oven must be compatible with the polymer curing and rock substrate.

#### **EXPERIMENTAL SECTION**

Selected samples were 6 types or rocks that are used as granite as natural stone for construction. A wide range of representation it was selected igneous rocks of several compositions (1 granite and 2 gabbro) and high-grade metamorphic rock (2 granitic gneiss and 1 metapelite). Petrographic identification of the components was made using a polished block and thin section under a Zeiss Axioscop microscope with polarized transmitted and reflected light.

The dielectric properties of the samples were measured at room temperature with a portable dielectric measurement kit using an open coaxial probe of ITACA. The sensor head is an open coaxial resonator emitting a low-intensity microwave signal, which

## AMPERE2015\_paper, last page

### CONCLUSIONS

Industry of rock and mineral processing can be benefits of microwave potential if is used properly. Dielectric measurements with the portable kit using coaxial probe can predict the heat effect in the industrial microwave oven, which simplify the process of application.

There is not found and evident relationship between colour and dielectric properties at 2,45 GHz. However, with the high-grade metamorphic and igneous rock studied, dielectric constant is affected by the major (QAPF) composition mainly and loss factor with the metal ores content.

Hotspots was avoided adjusting exposure time/microwave power density in 4 families that for most of application can be simplified in 3 or even 2. It make suitable in natural stone industry applications for granite.

### ACKNOWLEDGMENTS

Results have been partially co-financed by the STEP project (ECO/12/333123/STEP), project co-funded by the Eco-Innovation Initiative of the European Union CIP Eco-Innovation 2012.

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