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## Dielectric permittivity diagnostics as a tool for Cultural Heritage preservation: Application on degradable globigerina limestone

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### ABSTRACT

Most monuments and historical buildings in the Maltese Islands are made of the local Globigerina Limestone (GL). This type of stone, however, is very delicate and prone to degradation caused by the environmental conditions of the islands. Hence, for the preservation of the Cultural Heritage monuments, it is necessary to promptly assess the health status of these structures and, in particular, their water content (which represents one of the major causes of degradation).

Starting from these considerations, in this work, a time domain reflectometry (TDR)-based method for estimating water content of GL is presented. More specifically, the proposed method relies on estimating the water content value of the GL structure from TDR-based dielectric permittivity measurements. To verify the suitability of this system, experimental tests were carried out on a GL sample. In addition to this, also the dielectric characterization of GL was carried out. The results anticipate the strong potential of the proposed method for practical applications in the Cultural Heritage diagnostics.

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### 1. Introduction

The Maltese Islands are mostly composed of sedimentary rocks, such as the Coralline Limestone and Globigerina Limestone (GL), which have been used since prehistoric times for the construction of buildings and monuments [1]. Unfortunately, stones used in sculpture and architecture, as well as rocks in their original location, are exposed to environmental weathering. This results in modifications of the microstructure of the stones (such as open porosity, chemical-mineralogical composition of the phases, etc.), which, in turn, lead to changes of the mechanical properties [2].

This is particularly true for GL, which is highly porous and is typically used both in modern and historical architecture. Due to Malta's marine environment, salt crystallization in the stone's pore spaces (especially through alveolar weathering) is one of the major causes of damage in many buildings made of GL [3]. In addition to this, also rain and the presence of moisture is another major deterioration cause.

As a result, the study of water absorption characteristics of GL (which are fundamental when durability is being considered) has attracted much research interest [4].

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