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Salt damage generated on limestone as a function of environmental conditions

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Salt crystallization tests are performed on limestones with different kinds of salt. During the tests temperature on the sample and acoustic emissions generated are recorded. We selected two limestones, Lutetian and Caen limestone because they have been largely used for the construction of historic buildings in Paris area, N-W of France and S-E of England. These areas present quite similar climatic conditions for which climatic models predict an increase of the temperature and a decrease of the relative humidity for the next 100 years. The results obtained will be used for the prediction of the future behavior of building stones in the close future. We use sodium sulfate, sodium chloride and calcium sulfate as three of the most common salts present as weathering materials of this area.

Experiments are done on cubic samples of two different sizes: one set of 4x4x4 cm in which acoustic emission transducers are placed in order to record the microseismic waves generated by microcracking, grain displacement or any other process, during the crystallization process. Another set of samples are cubes of 2.5*2.5*2.5 cm in which thermocouples have been located on and within the samples in order to record the temperature evolution under different climatic conditions (temperature and relative humidity).

Two kinds of cycles are performed on the same samples, first classical cycles (imbibition, drying and cooling), under constant relative humidity (RH) conditions. After several of these cycles, another two type of tests are done, with only one imbibition period (at the end of previous cycles): temperature cycles under constant RH condition, and/or relative humidity cycles at constant temperature.

The two selected limestones have the same mineralogy but different physical properties (porous network structure, permeability, mechanical properties, etc). These differences can control the weathering behavior and play a fundamental role on the stone durability.

The combination of information supplied by acoustic and thermal techniques can help us to understand the physical processes responsible of damage generation on building stone due to changes of environmental conditions. This information can be combined with climatic models realizations for particular areas in order to estimate the future damage of building stones.

After the cycles the samples are observed under optical and electronic microscopy to try to understand how environmental conditions control: a) where crystallization takes place, b) the shape and size of precipitated salt crystals in the porous network c) changes of the rock microstructure on the samples surface.